MEDIA 72

The Lost Manuscript

Original subtitle:
Facts and Thoughts on Things for Schools

Theodor Holm Nelson

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Facts and Thoughts on Things for Schools

Theodor Holm Nelson

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A SURPRISE FROM THE PAST:

Fierce Predictions and Opinions in Search of Backing, 1966

I wrote this book fifty years ago, and I have not read it again till now. I find it quite surprising, all 233 pages (not counting the pages not numbered).

It has occasionally turned up in my papers and been churned into disappearance again. This time I figured it should be published.

What later versions there were of this work, or what became of them, I have forgotten, as many of my papers of that time were lost.

I can't say what, if anything, my potential backers did with this manuscript.

=== THE TITLE

This book purported to predict what media would come.

(Note that in 1966, the term "media" had just become popular, having been recently publicized by Marshall McLuhan.)

I intended to publish this book in 1967, and was looking five years ahead. Hence the title *Media 72*. I reasonably said in the manuscript that it was impossible to predict media more than five years ahead, and that has certainly been true for the half century since.

=== PURPOSE AND POLITICS

The purpose of this book was to get backing from a major company.

It was written in 1966, when I was consulting to Harcourt Brace publishers. Harcourt was at that time one of the most illustrious publishing companies in America. In my job interview I told of a glorious digital future. Miraculously, I found myself reporting directly to Harcourt's president, "Wild Bill" Jovanovich.

The main purpose of this endeavor was to persuade Jovanovich to back me in building a hypertext system.

I was trying to show him, by demonstrating credible knowledge across a broad front, that I knew enough to build the hypertext system I was proposing; I intended to create word processing and world-wide hypertext in a special mixture of my own.

The manuscript is dated October 27, 1966-- or at least that is the date of the table of contents.

Just the month before, in September of 1966, Jovanovich and I had visited the California lab of Doug Engelbart, inventor of our modern world (though few knew it at the time).* Doug showed us the mouse, the 5-finger keyboard, word processing, the expanded outline, and the jump-link, which of course had been one of my key ideas.

Doug Engelbart was obviously a wonderful guy, but Doug's emphasis was on workgroups, not a writing medium for the public, which was what I envisioned.

I was determined to build a different system-- I wanted to create a new literary structure for the millions.

I was sure it would happen.

A couple of days after the Engelbart visit, I got to fly back from California first class! Sitting with my boss, William Jovanovich, the president of the company! On that plane ride we plotted out my project. (By then my project was called "Xanadu", after Coleridge's magic place of literary memory.)

Jovanovich said he was going to budget the Xanadu project at $50,000 a year. Surely it would all work out.

It didn't, of course.

I've forgotten the historical details, but the overall story is clear.

I had not learned the maxim that in office politics, your enemy is the other department. Harcourt's IBM-based computer department did not want there to be a rival computer department they did not control, let alone using rival non-IBM equipment. There was maneuvering and my project did not happen.

=== WHAT THIS IS

This book enumerates many teaching possibilities available in the 1960s, from the conventional to various unusual systems available in that day. Many suggestions came from my imagination--from wacky book structures on to holographic hypertexts.

---

* I didn't mention in my autobiography, POSSIPLEX, that Jovanovich came to Doug's lab with me (which would have complicated that narrative). Jovanovich wasn't very interested, which was a bad sign. I believe he brought a female consultant who was dismissive of Doug's work, and they left early.

The book is liberally peppered with opinions about schools and the world.

=== CONDITION OF THE MANUSCRIPT

This is an orphan draft that probably had successors, but they are lost.

As you will see, it is reproduced from a faint carbon copy of a typewriter manuscript, typed by a secretary, with my own corrections in fountain pen and white-out.

It was not "input" because there was nothing to input it TO. This was a decade before personal computers, and word processing had not begun. (To put this in digital form would be a big project, since the feeble characters cannot be OCR'd.)

=== THE LOST OUTLINE

This book was hastily written. There is a noble outline at the beginning, enticing us with these headings:

Prolog
Dialog
Travelog
Analog
Catalog
Antilog

But this outline goes away. In the numbered pages that follow, this list stays on track only until page three, at which point these headings are forgotten entirely. (However, the last page, 233, is indeed the Exhibit that was promised for the "Antilog" section.)

In some later draft these headings may have been put back in, but this is unknowable.

=== THE TABLE OF CONTENTS

The table of contents (pages A to D) also goes off the rails, getting totally out of alignment with the actual numbered pages that follow. It says hypertexts start on page 154 and holograms start on page 163-- but in the body of numbered pages that follow, hypertexts aren't till 291 and holograms not till page 226.

So think of the table of contents as a promissory note, over-fulfilled.

=== A PREQUEL TO *COMPUTER LIB*

This book may be seen as a prequel to my rather influential book *Computer Lib*, which I published eight years later, in 1974. My views and fulminations, full of indignation and idealism, pervade this work, just as they did later in *Computer Lib*.

With this manuscript I was trying to get backing from a big company, which did not happen.

With my next major initiative, *Computer Lib*, I hoped to get backing from ANYbody, which did not happen either.

Computer Lib had much more appeal-- pictures, and a fervent pitch to ordinary people. In it I tried to interest the reader in the great world I thought was coming.

Like *Computer Lib*, this book describes and compares, and imagines uses for, many things the reader has not heard of. (And most of which no longer exist.) Indeed (as with *Computer Lib*), very few of these products had been heard of by anyone at the time, because I was reading and searching very widely. I wanted to create a new world, and was looking for components everywhere.

As with *Computer Lib*, I was trying to get backing by demonstrating credible knowledge across a wide front. And as with *Computer Lib*, it didn't work, because (like *Computer Lib*), it inspired people to do something else.

I have not yet gotten the kind of backing I hoped for, and perhaps it was never possible.

Ted Nelson
The Internet Archive, January 2017

=30=

from T Nelson

MEDIA 72

Facts and Thoughts on Things for Schools

Prolog

- Long Live the Book, But

Dialog

- On Systems and "Gimmicks"
- All There Is to Say About the Year 2000
- Teaching, Vividness, Clarity, Elegance and Fun

Travelog

- The Structures of Exposition and Presentation

Analog

- The Desiderata of Fine Teaching Objects;
- and what this has to do with hypertexts, hyperdiagram, &c.

Catalog

- Existing and Hypothetical Objects to Teach, Explain, Entice and Remind

Antilog

- In Praise of the Clear and Vivid Book: an exhibit with comments

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REVISED OUTLINE FOR NOTEBOOK, CATALOG SECTION

October 27, 1966

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The opinions expressed here are entirely (and in some cases exclusively) those of the author, who regrets that he did not have time to write shorter sentences.

I. PROLOG

Long live the book!

The book will not die.

There will always be Gift Books, and so on.

The other kinds will hang on for some time.

But already in our time we have seen the commercial-- if not pedagogic-- success of language labs and tapes, overhead projection and foils, New Math, New Physics, and, we hope, New English.

From year to year, the market's change seems slow. But like a cloud filmed in fast motion, it may seethe and boil rapidly inside out. Who knows what materials and grand systems will be sold in the years ahead?

II. DIALOG

A great deal has been said about the impending intrusion of technology into education, and breakthrough press releases are epidemic in our newspapers.

The motto of this report is a Russian proverb (which loses, in translation, its allusions to the newspapers Izvestia and Pravda): "In the news there is no truth, and in the truth there is no news."

I would like to offer this remark as a sort of reassurance that students are not about to be automatized, cybernetificated or otherwise loused up by Edujection or Thingamatronics. "Science" or "technology" is not about to show us "discoveries" with "proven instructional parameters" which will permit "exact tailoring of educational programs and facilities to an integrated systems approach for more effective goal achievement."

This is not to say that new machines are not going to pop up all over, and have a tremendous effect on education. It's just that the apparatus of scientific justification and technical metrics are largely doubletalk, if not downright fraud. Everybody is groping in the dark, all statistics are uncontrolled, most people are personally committed to specific machines and systems, and nobody understands anybody else. A common vocabulary of floating tech-words has imparted a misleading sense of talking about the same thing to a haphazard collection of people who are all concerned about the future but whose visions have no more in common than all the heavens of religions past.

There are several varieties of systematized fiction abroad in the field of educational gimmickry. One strain is concerned with the notion that teaching systems can, in the present state of the world, be compared minutely in terms of numerical or exact figures of merit, such as percentage effectiveness. Another is the embracing philosophy that individual components of "teaching systems" can be brought up to snuff, and continually improved, bit by bit and chunk by chunk, within an overall framework upon which all men of good will will agree. This is false simplicity. Anything can be made to seem precise by sufficiently narrowing its context, making small changes and comparisions, and demonstrating exact differences-- but no amount of such activity can justify an artificial setting, an unjustifiable constriction, or a misconstrual of something vast that calls a fragment by the name of the whole, and then, on slightly improving the fragment, proclaims the salvation of the whole.

I refer to much of the audio-visual and technological bosh being promulgated; I refer to the pervasive influence of modern learning theory, which due to a misleading linguistic analogy-- "It's about learning, therefore it must apply to education"-- has been allowed to becloud a number of important issues and prematurely to structure curriculum.

There is a vast fund of pseudo-technical would-be knowledge of different systems, elaborately worked out in misleading detail at the Ph.D. level. The apparatus of experimentation and justification is quite phony, however concrete the particulars may be. As ever in the history of inventions, this represents only a poke at a fraction of the innovative possibilities.

A NOTE ON THE YEAR 2000

Nobody who knows about technology, and its actual pace, would think of predicting past 1975.

I do not recall having heard a single prognostication for the year 2000 that was not possible to begin the following day, feasible within the technology.

Let us look ahead to about 1972, which is far enough away to think of trying completely new things but near enough at hand to worry about.

THE TRUTHS THAT ARE NOT NEW

The problem of education, as seen by those who deal in overhead projection slides and computer-aided tutoring, is that of making sure each pupil understands each important step in the fine instructional sequence, and has sufficient drill in the accompanying skill, if any. This is like assuming that the main problem in reducing automobile injuries is to improve the performance of the car. I like this analogy in several ways: the fine sequence *should* be understood, the skills *should* be acquired, just as the cars *should* be improved. Indeed, immediate improvements in education and in accidents may be achieved by such steps. But both in education and in traffic, the problem is more complicated, and more deeply involved with the innersprings of people: especially, the ways that people's motivation causes them to interact with things, and with each other.

To a very large extent the problem of education is not the problem of explanation and practice, but of motivation. Any fool is capable of doing fairly well in school, but few choose to. The supposedly fresh and pliable grade-school student has usually a developed, complex set of feelings and attitudes about his subjects and teachers; and all too often these feelings involve anxiety, anger and dislike.

If students are interested in their subjects, and possess enthusiasm, curiosity and the sense that their involvement and activity with the subject will be rewarding, they will teach themselves.

The opportunites of school are seen by most students, not as avenues of achievement, but as well-worn ruts of their own mediocrity or failure. All people, young and old, seek honor, in others' eyes and in their own; as the avenues to the legitimized honorable achievement seem less and less feasible, other forms of honor, such as the jollification of peers, take over as the comforts to hope for. It should be noted that most ways of demonstrating initiative in an ordinary school setting are *punished*.

If this view is right, the central problem of education then becomes helping students achieve a personal involvement with the material, a supportive framework of motivations. As they acquire a feeling of involvement and a commitment to being interested, they will seek to understand it all on their own and in their own style. (The teaching apparatus can itself become an obstruction here, for now the student is held *back*. There is in ordinary schooling no such thing as a "balance" between the curriculum and the student's motivations; he is either pushed to do the assigned work perfunctorily, or self-propelled and carried beyond it.) Students who are properly motivated, and have access to material, will choose it and study it so as to fit their own ways and predilections. This means that different students can find different byways attractive, each in his separate way.

I will not try to classify cognitive styles here. The issue is highly contaminated by the existing, stereotyped divisions (scientific, arty, plodding, etc.); it involves personality, ideology and much beside.

I firmly believe, for reasons I do not want to go into here, that every subject is intrinsically interestings and can be interestingly expounded and clarified; that every subject can be comprehended by a person with any type of mind, though different people will have to approach a given subject differently; and that the number of ways and sequences in which any subject, or mixture of subjects, may reasonably be taught is astronomical. (Indeed, every "subject" is an arbitrary clutch of topics, procedures, catchphrases and associations which is held together more by tradition than commonality. Exactness of definition of a subject is no excuse; an "exact" dfinition may be found for practically any grouping of things to study.)

The individuation of involvement -- the turning of a field to suit one's personal style of thinking and visualizing -- is a necessary thing too few people understand. "There is a way you have to approach mathematics" and "There is a way you have to approach English" are myths so deeply entrenched that we may expect them to remain a part of our natural heritage for many generations. I believe that this has come about by a special kind of Darwinian process: the teachers in a given subject alienate or confuse all but those whose minds work the same way and whose way of organizing work is similar. These people in turn teach the subject twenty-five years later, secure in the knowledge that you have to have a special kind of mind to really appreciate this subject, and that you must come to its insights through a certain sequence of expositions and exercises. (This is not a truly Darwinian process, since it certainly does not insure the survival of the fittest, but rather of those who fit in.)

The notoriously bad arithmetic of some great mathematicians is an important example here. If these people had not had some channel for achievement in the subject independent of arithmetic skill, I doubt that they would have become mathematicians. Such a channel is usually not found by American children failing in arithmetic.

Individuation of involvement is something which the teacher finds unsettling, if not subversive, since the hint that there is another relation to have with the subject bids to undermine the legitimacy of his whole personal involvement with it.

These are the matters, in my opinion, that determine whether and what people learn in school. Learning theory, that branch of experimental psychology, does not apply to education. It applies to rats, pigeons, and people who habitually learn nonsense syllables.

Given these premises, then, we need to understand what machines and components will be of use for teaching in the next five years. To explore these ideas is the intent of this report; but first we must look at the most general matter, the procedure of systems analysis itself.

SYSTEMS ANALYSIS

Today, by and large, we do not stick by given designs and inventions, but consider the different parts that may be employed and combined into systems, and try to arrange these systems for the best result.

There is nothing new about the systems approach. Any source on the organization of the Roman army (to take an arbitrary example) will show that conscious knitting of diverse components into a functioning whole through crafty decisions, simplifications and tie-ins is nothing new. A recent sociological tract has denounced the systems approach in any activity involving people, under the premise that involving people with "systems" reduces their position to that of Kantian victimization. This is silly. The roles of engineer and conductor, for example, are parts of an overall system for running trains; the roles of teacher and principal are parts of an overall system for education. The fact that these roles have been designed into a system neither brutalizes ~~them~~ their occupants nor "denies their fundamental individuality," as the phrase goes.

Howe has called the American teaching system a "non-system;" this is not so. Schools all operate under more or less the same overall system, in which students are exposed in batches to a single teacher who processes, inspects and rates them.* We might draw a distinction here between systems and gimmicks.

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*Curiously, it is the student who fails, not the teacher, though this is entirely different from the way that industrial processing stations are graded. Save in the most extreme case, the teacher cannot fail, since the tangible result of his work-- the list of grades-- can be produced by absolutely anyone, and accepted automatically. Conversely, of course, the teacher cannot especially succeed; his only reward is the gratitude of posterity, which at most means being extolled in

Reader's Digest.

I would like to propose this distinction: "gimmicks" are objects which may be added to the existing system, while "systems" require the existing system (the teacher setup) to step aside. A gimmick is a badly grafted innovation, one that doesn't work well when grafted on the present system. Thus teaching machines, language labs and classroom filmstrips are gimmicks; blackboards, microscopes and teacher's manuals are not. They are accepted components.

These remarks are intended to point out that a gimmick (or "gadget") is something awkward, and the term has nothing to do with electricity, novelty or the popularity of a component.

The implications of this way of thinking, then, compel us to look at both whole systems for teaching, and ways that new components will tie in with each other and the existing ones. The good system will have the teacher as a part, building on his strength and around his weaknesses.

But the systems way of thinking has not yet touched education, or even audio-visuals, very deeply.

An example of the way educational systems have been sold might be "the audio-visual field," especially projectors. There have been problems in the use of audio-visuals that have not been properly understood either by producer or consumer. Moreover, the selling of a-la-carte hardware and adjunct materials for haphazard use in the hardware will not do in the future. Let me elucidate these two points.

The projectors have been sold on the basis of "you can probably do wonderful things with this somehow;" the materials have been sold on a basis like "you've probably got a projector for these around someplace." But hidden problems arise which elude both ends of this chain. Considerations of inventory and filing, workspaces and activity flow, and finally of smooth integration into the classroom discipline and the curricular expository stream, have been largely neglected. Few besides the teacher know the logistics and operational snarls of freeing and operating the projector, checking for permission to use it, finding the wall socket, the extension cord and the plug adapter; the need for a worktable in the dark (and a light for it); incorrect slide trays, slides upside down or in the wrong order, jammed slides, broken tapes, and the burnt-out bulb. The designer of the machinery or the creator of the slide-package can say it's all the teacher's (or the school's) fault. The system designer has no such excuses. The system he designs must operate in real environments. If a projection worktable is needed and not likely to be handy, it must be built into the projector case; if the slides need cataloguing and sorting, they must be packaged and labelled so this can be done. Not the naked facility, then, but the finished package, must be the product.

It will probably be necessary then, to sell whole pick-and-choose packages *and* tie them in to the way things are done. It will not do to ~~accentuate~~ put gratuitous and irrelevant material or allusions [illegible] in the slides. It will not do to make a complete joke in the slide; the slide may build up a joke, but the punch line belongs to the teacher. This is systems analysis.

This is not a complete change. Today's textbook publisher does not simply sell books. He is packaging and merchandising *information complexes*-- regardless of their packaging. The books, tapes, overhead projection foils and bonus materials travel as a pedantic squadron. What units are bound as one-- like the text-- or hang separate or loose, like the tapes and foils-- may depend on psychological, aesthetic and practical judgments. But irrespective of the package divisions, or the progression of years and tracks in a book series, it is a unified system. The system may never be adopted as a whole; that is, the system is often bought and used a la carte.

But what kinds of materials will they be? How will they relate to each other, the curriculum and the structure of classroom activity? Have the conventional arrangements any justification? (For example, the teacher's manual: does the teacher really need a visible but inaccessible source of knowledge, like the oracle's fire?) Next to these questions, the matter of the kinds of electrical and mechanical systems that will present the things seems a small one.

THE STRUCTURE OF CURRICULA AND PRESENTATIONS: INSTRUCTIONAL LATTICES

We may think of a lecture, a course, and the whole of elementary education as having the same kind of connective structure. That is, they are lattices of presentation-- fishnets of connections and progressions that stretch off in time-- rather than simple sequences.

We may distinguish between the gross structure of a curriculum-- the major headings, points and sections-- and the fine structure, the connections and expositions that are subject to variation, say, within a school system. The former is decided by history and in fighting, the latter by the individual teacher and by accident.

There is probably a laughable relation between the exactly structured curriculum and the tumbledown blur of what the child remembers or learns. (I would guess that in only one field is there less correspondence between the sanctimonious official schedule and the personal experience, and that is in the field called Correction.)

This macrostructure, the curriculum, evolves gradually within a school system and is a political football. Much of the microstructure is accidental;

some of it, the explanations and ways of tying together, are a cherished part of the teacher's repertoire. The business of selling school materials is deeply concerned with tying its materials to both of them. Usually the materials tie in with the gross structure. But the materials need not themselves correspond to the lattice form of the instructional sequence: they may be discrete and unconnected units, or they may be arranged in separate "garlands" (Alistair Reid) whose connections may or may not be tied in with the planned or resultant curriculum. Or they may follow the gross structure, but be stratified, so there are materials available for different levels of interest or ability. (This is done in most math books, in such a way as to intrude on the sight of those who can't or don't choose to do the enrichment work. This has obvious psychological consequences.)

There are two ways in which current instructional research is influencing the instructional lattice. The first, and simpler, is by providing new instructional lattices that are more elegant and perspicuous (the new math); the second is by seeking out implicit leaps and filling them in. Conventional instruction has assumed that certain "leaps of insight" are indivisible, chasms across which the student either makes it or doesn't. The result is exposition in which the student is supposed to discover for himself some important principle but doesn't, or sets of exercise designed to strengthen an understanding, of which a student may be unable to do the first one.

Programmed education has demonstrated by example that most if not all these leaps of insight can be carefully prepared so that no one can miss them. (This stepwise breakdown is apparently what Teco, Inc., a programming firm, means by "Mathetics," that which it says it practices.)

In grappling with the curricular lattice, however, programmed learning has managed to create a new problem. That is the dual problem of making sure everything is covered, on the one hand, and preventing extraneous interactions and imbalances among curricular parts, on the other. This is because programmed instruction foregoes handing over responsibility for the fine structure to a person, repudiating his possible errors but at the same time relinquishing his possible corrective influence.

The overall gross lattice of the curriculum, then, furnishes the topics and headings for the materials to be published. These materials must fit in with this presentational system. But whether these materials can be smoothly integrated into the existing system involves several other things. The salable system of materials must tie in also in operating convenience, that is, fit in the room use existing electricity, walls or whatever, and be visible or audible within the ranges normal to human beings.

Perhaps the most important aspect of these materials, though, is the sociological.

For a system to succeed in the classroom, it must be satisfactory both to the teacher's considerations and the students' considerations. For a system to succeed in being sold, it must satisfy the administrator's considerations. The publisher's considerations embrace all three of these. I will ignore the administrator, since that is the salesman's problem; indeed, selling consists in part of communicating the good features of the material from the points of view of teacher and student.

The sociological considerations that go into a teacher's reaction to materials involve the fine structure of presentation, i.e., whether the materials tie in with the way (and sequence) he likes to expound and present. The hidden persuaders, however, are more closely related to his sense of image and position. The materials must not embarrass him, or threaten to, either intellectually or mechanically. They should appeal to what he thinks is his role-- in a way, the coach's whistle and the geographer's pointer show some of the differences that can exist here-- and the materials should affirm his status, building him up in relation to the class.

Note that building status does not necessarily mean increasing the teacher's authoritarianism or even personal direction of the class. At the extreme case, it might well be possible to enhance the status of the teacher while effectively removing him from participation entirely. Allegorically, I visualize the teacher's desks rising until the teacher is almost to the ceiling, with audio-visual presentations playing around the mighty pillar his desk has become: he seeming to be more as he becomes less. An arrangement that allowed the teacher to control the timing, but not the order, of a media mix might have virtually the same effect: everyone would have the sense that he was pervasively participating, but he would be having no influence.

To be effective from a student's point of view, teaching materials should (first of all) be attractive, having the simple appeal of the well-made, the colorful, the interestingly palpable. (He must handle these very materials, physically and psychically, in a way the teacher need not.)

To be attractive to the student the materials must go further than this, however. They must be not insulting, they must not contain implicit digs at his youth, his ignorance, his dependent status and lack of autonomy, his pimples. They must appeal to his real self-image and concerns; but since both of these have many facets, this can be done any number of ways.

To put it at the universal level, though-- and this is true for adults and students on any level-- materials which the student is to use and manipulate, especially self-study materials, must have some privileged character. They must enhance his sense of status, or they will be neglected, damaged or lost. (The extreme case, and an instructive one, is the alleged refusal of doctors to look at patients' records on microfilm. The microfilm reader undercuts the doctor's whole position.)

The self-study device must be sensed as a privilege to use.

It must also make sense, and not be stupid. The things the students are asked to do must make sense to them. That is one reason for distaste toward programmed instruction: much of the rote response, while it helps in stamping home the material, is stupid.
(When "human engineering" begins to take into account man's higher faculties-- such as irony, resentment and whimsy-- and recognizes them as constraints requiring satisfaction, it will be worth considering.)

So much for the tangible considered in the abstract-- the objects themselves with their meanings ignored. Let us remember what teaching materials represent-- fields and subjects of study.

The most important thing a student can derive from any teaching-- whether that teaching is embodied in a person or a book-- is the sense of being welcome in a field. Wherever I have looked or asked, this experience is a common memory for those who have gone on in a subject. The student's personal reaction to the fields and subjects that the teaching materials represent is the most important event is all the clashes of student, teacher and material. Materials made for schools should be welcoming, and create a direct relation between the student and the subject, not mediated by the teacher, and make the interesting features of the subject clear.

We might distinguish between types of object for possible use in education. (I claim no special vlaidity for the following enumeration, but it seems to me to describe approximately the way existing and proposed systems are divided. This, in turn, is not necessarily "natural," but rather a development of the way schools happen to be organized.

Demonstrative/objects & explanatory	(the blackboard, the filmstrip)
Self-study objects	(the language lab, dissection frog)
Quick-look objects	(the wall chart)
Explorable Objects	(the dictionary, the class guinea pig)

Mnemonic objects (the "Five Keys to Good Hygiene" poster; the alphabet song)

Note that this division is not exclusive, and many things can be in more than one category; indeed, the textbook and hypertext can be in all five.

However, the desirable traits of these objects are not divided up; I would say that all these things should have the same traits. They should be these: clarity, simplicity, appeal; vividness, comprehensibility, memorability. (Memorability probably divides into the traits of being enumerable and visualizable.) Note that "simple" does not mean "oversimplified," "vivid" does not mean"garish," etc.

I believe we should honor those who are trying different things, wrong through the particulars (and the theories) may occasionally seem.

There are no breakthroughs; but some people seem determined, by power of effort or persuasion, to make artificial ones.

A word about the value of artificial breakthroughs: they focus determination and permit reorganization which would not have been done otherwise; the gimmick that it happens around may not be important. The American way to make reforms is not by criticizing and revising, but by diverting attention and function to a new project which gradually takes over.

Thus it may be that experiments and ideas which are not particularly worthy in themselves may have a loosening effect upon the organization of schools, and gradually permit more and more students to find their own way and go it. Perhaps the secret force is curricular power: giving credit for activity, which permits people to change the ways they study, is the thing, and the gimmicks are just an excuse. Anything that leads to the unleashing of human initiative in the world of ideas is fine.

The subject of this report is not Pedagnology, or Teachotechnics, or any other portmanteau that tries to make the reader believe in the exactitude of considerations about teaching. But I will accept another coined epithet: this report is an exercise in Technosophy, the search for

understanding of the implications of technicality in their complexity and nuance of sensible characteristics: that is, their feel, the things about them that can be sensed. Technical analysts seem to stop short when the gross features of a device or system are understood; yet when we talk about things that are to be seen and felt by people, the tangible qualities and impressions it gives are vital. Somehow within the technical frame of reference these aspects seem trivial, if not beneath dignity. But consider the publishing of books: the tangible qualities, the aesthetics of the product are intrinsic to it. When a publisher ponders, e.g., whether to use paper made of cornstalks, such technical considerations as its web strength, ink absorption, etc., may not be as important as the way it feels in the hand. We must pursue, not just the mechanical details, but the tech-knowledge-y sense, beyond that, of the way the system feels to people after it has been disenchanted, deglamorized and worn.

OBJECTS OF INTEREST EMPLOYING PRINT TECHNOLOGY

1.0 COMPONENTS

"Print technology" embraces a tremendous range of techniques suited to an enormous number of uses. The phrase "print technology" makes us think of Gutenberg and the movable type slug. But in the larger sense, of course, it includes both letterpress and offset (sheet and web), gravure, engraving, engrossing, embossing, silk screen, mimeograph, spirit duplicating and embosser-ribbon (charge-a-plate) printers. Most of these have the capacity for presenting images other than typographical. Most of them, if properly studied, may be turned to original and attractive uses; some are more luxuriant and have more prestige than others. Their economics of scale are vastly different.

[redacted] These systems are considered "conventional," not really because of any shared properties, but because they are all easily available and interchangeably to be considered. Partly what is "conventional" is a matter of convention, then. This is one reason that automatic typewriters and computer page printers are not "conventional," even though they use print technology.

Basically these methods put *images on paper*; the paper is a medium of both storage and presentation. After imaging, the paper is packaged in some tangible fashion, and accessed within that package by the user. The access may be by an address (page number) or some orientation built into the overall package-- thumb-indexing, the handling of specific fold-outs, and so on.

While there are any number of ways to cut, fold and arrange odd-sized printed sheets into whole objects, the conventional permanent page binding is far and away the simplest way to arrange and store large quantities of written materials (say, over several hundred pages at a time). However, for smaller quantities of material, particularly where we intend that the finished object shall make a distinctive impression, other forms are possible. These may involve odd shapes, odd folds, color, embossing, tip-ins, transparencies, rich materials and finishes, *mixed* materials and finishes, die-cut shapes and windows to open.

Advertisers know that beautiful printing, heavy paper, pretty colors, odd shapes, and odd tangible things-to-keep attract us-- not just the morons among us, but the doctors and executives, on whom are showered the handsomest of these things. There is fascination in raised surfaces and holes; and for those not forbidden by consideration of dignity, there is an appeal in manipulative invitations, such as fold-outs, glue-ons, tuck-ins, and even tab-and-slot construction of three-dimensional toys.

Lest it be objected that tactual and manipulative aspects of these objects are base and unworthy of notice, I would like to remark that *most* criteria of [illegible] "quality" for books are likewise elegant touches that appeal to taste and touch; otherwise the only criteria of a well-made book would be durability and legibility, and our best productions would resemble [redacted] the workaday output of the U.S. Government Printing Office.

Though fold-outs, bend-ups and tip-ins, odd cuts and mixed paper stocks are expensive, but they have a strong impact on the handler, creating a distinctive impression and better recall. They [redacted] tickle the fancy, and spur us to interest of captivation. Other techniques can give us orientation in a subject, and a vivid pictorial sense of it. (See Exhibit accompanying this report.)

[redacted] Illustrations are wonderfully helpful, and picture books most helpful of all; but let us consider specific pictorial techniques, based on print technology, that can be of special help.

The picture surround. (See notes in Exhibit accompanying Paddle-to-the-sea,) and 2.4 below, "the Fliptych."

Non-simple illustrations. By "non-simple illustrations" I mean illustrations which do more than simply present a three-dimensional view of an object, and take steps to make a thing clearer. Basic examples are the diagrams and cut-aways of TIME'S illustrator Chapin; [redacted] more intricate are the "phantoms" of the brain artist Krieg. (The brain, considered merely as a three-dimensional object, is highly intricate, and Krieg's "phantom" technique consists of drawing the essential part firmly and connecting it to smoky, transparent drawings of its surroundings.)

Another technique, scarcely new but too seldom used, is the transparent overlay. The purposes to which this may be put are endless: for example, labels for objects in a painting or photograph; physical layers of an object illustrated. (An interesting example is Krieg's compound painting of the brain, available as a small book, in which the entire brain may be dissected by the reader's turning of the pages.)

1.1 ITEMS from print technology.

Compared to books and magazines, leaflets and pamphlets may seem uneconomical to produce and distribute. This is true only if their other advantages are ignored.

1.1.1 LEAFLETS (distributed separately)

There are many fine things about leaflets. They are *distinct*, providing memorable visual and tactual impressions. They are complete, and encourage concentration; in this respect the leaflet is quite unlike the textbook. The not-yet-opened thickness left to go at the rear of a textbook has a forbidding, foreboding character. The front of the leaflet can be inviting. To feel master of a leaflet takes little time. One is easily oriented to its contents and their layout. The same contents, put in a book, lose their tactual interest. Moreover, they no longer have their own *covers*, which is important.

The medium of the well-printed, colorful leaflet is *intrinsically* exciting. Dull contents can relinquish that advantage, but good contents will get people into the first paragraph. The contents must take it after that.

Note that the cheap-paper no-illustration leaflet, and white-paper leaflet with one-color artwork, are intrinsically dull-looking--probably because of religious and political tracts.

It is worth noting that leaflets are a principal form of advertising at conventions and in stores.

1.1.2 PAMPHLETS (distributed separately)

By "pamphlet" I mean any small printed object involving more than one piece of paper, unified, and having no external binding.

A pamphlet has all the good features of the leaflet except perspicuity: there are more surfaces to look at before you are completely oriented. But a special advantage is this: Every pamphlet has two covers, back and front, while a chapter in a book has none of its own.

Pamphlets with fancy folding, or loose inserts (and especially pockets for them), add the fascination of manipulating to the purely tactual interest of the object.

It is worth noting that pamphlets are a principal form of advertising by mail, especially for products whose competition is essentially identical, or where there is ingrained skepticism--

in short, where sales resistance rests on nuances of impression.

REPRINTS have been successfully published as pamphlets by Bobbs-Merrill (covering the social sciences) and the Scientific American (natural and social sciences). We may presume that these are chiefly used in college classrooms, though there may be a secondary-school market.

STAND-ALONE PAMPHLETS FOR STANDARD CURRICULA are currently at the drugstore level-- e.g., Analysis (with Synopsis) of King Lear.

Whole subjects are not ordinarily covered or augmented by pamphlets, but the College Outline Series range toward the pamphlet at the short end.

Quality houses usually stay our of this sort of thing, but if they can keep up their quality there is no reason that they should. For example, why not publish handsomely made illustration pamphlets--four-color maps, overlay illustrations--for history or the sciences?

1.1.3 LOOSE SHEETS

Vis-Ed Co. gets 79¢ for a very brief compendium of names and dates, facts or definitions.

It should be noted that loose sheets are a principal form of advertising where a) the goods speak for themselves-- reading the specifications of the product wholly suffices to make him buy, or b) it needs to be filed in a folder or catalog binder for future references.

1.1.4 POCKET QUICK-LOOK DEVICES

Pocket quick-look devices-- reference cards, ponies or cram cards, depending on your viewpoint-- are usually frowned upon, though for no good reason I can see. They provide a quick look for answering questions, obtaining orientation, checking recollections, and so on.

Examples include the decks of pocket-sized plastic anatomy cards available for students of anatomy.

Some distaste for the quick-look device may arise from the exam-cheating pony, which can be any small paper object laid out for quick-look question-answering by the student. Such ingenuity and effort should be rewarded, not penalized! Anyway, folding cardboard ponies could be printed in bright colors, to discourage cheating in favor of legitimate memorizing. ¶Perhaps another reason for distaste is that the quick-look device seems an unfitting digestion of the knowledge which people feel should only be kept within the grandness of books. However, students frequently strive to adapt the book itself as a quick-look device, especially by underlining, and more recently with yellow dye markers. (Besides, mnemonic structure is built around oversimplification.)

There might be untried approaches to quick-look cram cards. For example, [redacted] a whole set of different cram cards for one subject, cross-cutting the subject in different ways, and with a heavy use of schematic illustration, might [redacted] be awfully good.

Pocket reference cards are often sent out as advertising, in which case they bear information useful in the same field the advertising addresses. They tend to end up in desk drawers.

Such objects are regularly used by computer programmers, since once the programmer is generally familiar with a machine, practically all he needs is a list of the instructions it will carry out. [redacted]

1.1.5 QUICK-LOOK DEVICES: WALL CHARTS

Examples of common quick-look wall charts [redacted] are the Histomap, the Periodic Table, the Graph of the Nuclides, and the graph of biochemical transitions offered by a chemical firm.

The comparative silliness of the Histomap, the only above wall chart relevant to secondary education, stems from the brevity of entries and the lack of room for background material. You can't use it for cramming. You can use it for orientation, and to compare times that things happened. In other words, it best imparts relational, rather than factual, information. But this is may be a function of the way it was edited.

Wall charts are often sent out as advertising, with the name of the maker firmly on them. However, unless ~~this~~ the chart's reference information is important enough to the receiver to make him cover that amount of wall with it, it's useless to the advertiser.

The wall charts mentioned all have some overall pattern-- swirl, composition-- that makes finding something quick and comprehensible. A wall chart of "Sociology" or "Philosophy" would be much harder, but perhaps an interesting exercise.

1.2 ITEM PACKAGES

Since it makes little sense to talk about selling individual leaflets and pamphlets, save conceivably on a vast scale (like the Bobbs-Merrill reprints), let us now consider intergrated ways that such items might be collectively sold.

1.2.1 THE PAMPHLET DISPENSER

In gas stations, railroad stations and photo stores, one finds racks full of leaflets and pamphlets, free to keep. Marked "HELP YOURSELF," such a dispenser could be kept in classroom, library. or school recreation [redacted] area, much as such a thing may be found in photo stores, gas stations or railroad stations. The students are free to take from it. The contents are colorful, interesting, and tied to their studies as either quick-look or honor material. If they had to take them it would spoil the idea. The point is that unless the material is interesting and clear they won't take it. If it is, they will. Contents might include history, four-color scientific diagrams, good-looking maps. This would be sold to schools by the rackful and the refill, like greeting cards.

Textbooks are by convention otiose, obtuse and difficult, not because they have to be, but because the buyers think they should be. However, pamphlets like these, being unusual, would be under no such constraint, and could be as breezy and informal as wanted.

This represents a chance for initiative, and removes feelings of guilt at not knowing the contents when the object is set aside. With luck, students could become proud of knowing the different ones, much as they are proud of being able to recite the different bubble-gum comic strips.

TIED-IN PAMPHLET DISPENSER. A more focussed possibility would be to offer a colorful pamphlet rack in connection with a given subject. In connection with the American Revolution, the student could help himself to pamphlets called "When Washington's Army First Assembled," "The Way It Looked to King George," "What They Were Reading in Boston on the Eve of War," and so on.

- Handsomely printed single reprints from American Heritage. These could be clustered around textbook headings, such as the American revolution, the trek west, the industrial revolution, the wars of the twentieth century. But it may be that holding to such hackneyed headings is not the best approach to enrichment material: as soon as enrichment material is artificially squeezed under the major headings of the course outline, the student may begin to feel the leash around his neck.

1.2.2 THE PACKAGED PAMPHLET SHELF.

A shelf is different from a dispenser: impulse grabbing is discouraged, and presumably the contents are to be given back.

Shelves of enrichment materials, in pamphlet form and keyed to different interests and abilities, could be prepared for all standard subjects. These would be under teacher control, loaned out personally to specific students, with their return enforced by whatever standardized demerit control there may be.

This could be either an adjunct to text series already offered, a "classroom resource" (to be used with competition materials as well), or a library resource.

Compulsory pamphlets. Central, rather than adjunct, use of a pamphlet dispenser also has certain good points. Each assignment, a pamphlet handed out or picked off the rack, has a new immediacy; and, for students used to failure, a self-containment that does not prefigure new failures on assignments to come. And they are fun to have.

■ Science Research Associates is already offering such a system for various elementary subjects. A box of pamphlets is supplied for the whole class. There is a group of pamphlets for each topic to be studied; and within each topic, there are different tracks, so that students at different ability levels can be studying the same materials at appropriate shades of difficulty. Obvious drawbacks: 1) supplying three Basic, five Middle and three Honor pamphlets (or whatever the mix is) makes little concession to random sampling, and as much as three times as many texts may have to be stocked, A greater quantity of materials is required, anyway. 2) Although the ability-grading seems to be fairly well disguised, how long that can fool children I don't know.

● Bonus shelf at all levels of difficulty for the Adventures series. On this shelf are a number of pamphlets, all fascinating, that the teacher hands out to specific students. (A table is given her of the specific interests, emotional appeals and levels of the materials; she "uses the personal touch" in handing them out.) Rather than specific testing, the end-task can be to write an essay in class on the specific outside reading; that way the teacher can seem to be bestowing a nice personalized gift, personally chosen, rather than charging the student with a particular rote task.

1.2.3 PACKAGED KITS AND DOSSIERS

It may not be obvious, but there are a number of reasons to consider packaging irregular and odd-shaped leaflets, maps and other printed materials together, rather than binding them together. First, each item is more vivid and distinct. Second, each is an attractive thing unto itself. Third, they can be scattered around and compared--this is especially the case with maps--much better than if they were all bound together.

Putnam and Sons here distribute an English production called the "Jackdaw." This is a heavy paper pouch, about letter size and attractive, containing maps, illustrations and narrative material on a historical topic. The one I looked at, on the Spanish Armada, I liked a lot: the contemporary maps and illustrations were larger than they could be in a book, and the different colors of the items made the things attractive. However, 1) the paper was obviously cheap, and 2) the text was a single narrative chapter, merely broken up into numbered chunks to be read in order. This made it seem a little silly, since the separateness of the pamphlets bore no relation to the continuity of the text. Independent and supplementary documents would have made it better, providing justification for the separateness.

Packaging the kits beforehand is rather like the compulsory-pamphlet approach. However, it lacks the fun (or drudgery, depending on the teacher) of picking or receiving the items one at a time. For this it substitutes the prepared luxury of spreading the parts around you, of reaching into the material up to the elbows, as it were.

Note: where desk space is lacking, the kit is awkward.

It is worth noting that kits are a principal form of advertising for magazines, record clubs and book clubs. (In this sort of advertising, which is factual if not torrentially so, the kit is often combined with glue-ons and tuck-ins.)

1.2.4 LOOSE-LEAF NOTEBOOKS FOR LEAFLETS AND PAMPHLETS

Under either a compulsory or a voluntary system, binders could be provided in which the student could collect leaflets and pamphlets. The binder could contain irregular pockets, for odd-sized leaflets; it could have a ring-binder spine, and subject all leaflets and pamphlets to a common punching discipline; or it could have provision for both regular binding and irregular oddments.

Eastman Kodak has for a long time sold several different "handbooks," consisting of several pamphlets in a ring binder that has room for many more. Conveniently, the ring binder just fits the anomolous Kodak pamphlet punching.

1.2. NOTE-TAKING AIDS

Teachers want students to learn how to take notes, so they generally say, "take notes." This is not effective. Probably the best way to learn to take notes is to know in advance what sorts of things you want to get out of a lecture, and get those down as well as possible. Adjuncts might be helpful. For instance: a pre-printed workbook (something like a pre-printed stamp album) with various illustrations requiring explanation. The teacher, naturally, would need to stick to this outline. (Presumably it would be keyed to a line of textbooks.) Another possibility: illustrative stamps, with caption but without explanation. These could be stuck on after a lecture in anybody's notes, providing both tactual fun and review, and would not restrict the teacher.

1.3 BOUND OBJECTS, OTHER THAN BOOKS

1.3.1 THE MAGAZINE

The magazine may be thought of as a collection of leaflets or pamphlets bound together, for convenience and for other reasons. I say that because its contents are not prerequisites, one to the the other, and because its contents (except for "special issues") do not ordinarily cover different sides of a single theme. There is less pressure on the user; and he has less of a fixed criterion of what he should get out of it. He may mosey freely.

Scholastic magazines tend to be unattractive (at worst, printed on newsprint) and insipid, the lowest common denominator of the inoffensive and uninteresting. Real magazines are inconvenient for class use.

It might be worthwhile to think about publishing a year's worth of "magazines" for standard high school courses and sending them out annually, with only minor chages as required. This could centralize editorial planning and yet hold to the contempo~~anriety~~raneity of the magazine format. The magazines could be attractive, like pamphlets, but not need continuous stocking by the schools.

1.4 BOUND BOOKS

Bound books require mention here for what they tend not to be. Bound books tend to have dull layout, little in the way of mosaic visual structure, and few prior orientational helps for the reader. A reader who begins a subject cold can usually get little help from the table of contents, for instance.

Yet print technology is rich in possibilities for orientation and enrichment; it is the makeup and appearance of books that fails, not the medium itself.

(See Exhibit.)

Picture books are beloved things. Everybody likes them. Why aren't they used ?

Why can't there be published rich adjunct books, not holding to some fixed standard exposition-- even with little text at all-- but containing pictures, maps, orientational devices, conceptual mosaics, and ao on?

LIFE is now publishing several such series, I believe.

1.5 UNCONVENTIONALLY BOUND BOOKS

The ordinary book has pages all the same size with no cuts in them. This is not compulsory.

1.5.1 PAGE CUTS

It is possible to cut, punch or slit book pages in various ways. For instance, a recent cookbook entitled First Slice Your Cookbook (Hawthorn) has slit-across pages so that parts can be combined. It is possible, for effect, to cut pages many other ways. This has attractions that may sometimes offset its sometimes exorbitant cost.

This was one of the attractions of Flair magazine (about 1950). But readers may find it precious, like that magazine, and it is less durable.

1.5.2 UNCONVENTIONAL BINDINGS

The DOUBLE SPINE would permit independent turning of two sets of pages.

(illustrations)

(It might be possible slao to fold the long side in the middle, permitting it to be shelved in the ordinary manner.) If the text is bound on one side and pictures on the other, the text can be changed for foreign-language editions rather easily.

Another double spine arrangement, with pages longer than the distance between the spines, would permit the viewing of three large page areas at once, and also interleaving the materials bound on the two spines in different ways according to purpose.

CATALOG BINDINGS permit a whole spineful of materials to be pulled out of a rigid spine at once, and shelved. This might be useful where different sets of materials needed to be placed temporarily in a given binder.

Irregular bindings are felt by most people to be "gimmicky." But we may turn this idea around: conventional bindings use a "negative gimmick," that of non-intrusiveness. While this calls attention to the subject-matter rather than the packaging, it still forfeits possible advantages. Conspicuous or interesting bindings, like those of the colorful Adventures series of 1952, possess all the nice-thing-to-have psychological advantages.

1.6 BOOK COLLECTIONS.

Books need not be sold alone; trade books, for example, are often sold as sets in slipcovers. Why not sell full shelves? A standard-sized, interlocking bookshelf module, and offered with standard shelves-full of books (both hardback and paperback), would be attractive as a classroom adjunct for standard courses, as a quickie method for those charged with building libraries, as an aid for government education programs, in civil rights work, and so on. (I have heard that Southern emergency teaching projects were using a standard modular bookshelf, — the shelf, that is, and not the contents — but I have no details.

2.0 NOVELTY AND PLASTICS TECHNOLOGY

2.1. MNEMONIC AND INSIGHTFUL OBJECTS

The makers of cereal and Cracker Jack have long known the appeal of small tangible objects as favors. These objects are of no particular interest and would rarely be bought separately, but their appearance in the context of eating-- I do not intend to be Freudian here, but the atmosphere of consumption must figure-- makes them somehow appealing.

As keepsakes, then, there is something quite appealing about toys or favors, especially if nicely made. (Polyethylene in particular is extremely cheap in quantity, but can have great appeal; solid nylon is also of interest here.) If such small objects could be given mnemonic value-- like an inch-high bas-relief of "The Spirit of '76," or a tiny toy astrolabe-- they might be appealing mnemonic additions to the grade-school course. Besides the text and classwork, presumably other materials would be necessary, such as explanations, wall charts and carrying boxes; but these objects could be distributed, one at a time, in the ordinary classroom setting. If they came in different colors they would be traded, and obtaining the "complete set"-- and preserving its collateral material-- would be a mark of prestige.

2.2 FELT (and VELCRO) BOARDS

Felt boards permit the quick display of prepared cutouts in different arrangements, as long as the cutouts, like the board, are made of felt.

Velcro, a scratchy plastic material

containing tiny hooks, clings much more tightly to felt than other felt, and consequently rather heavy objects may he hung from the felt by Velcro patches. Prepared exhibits of this kind are interchangeable and cheap to make. Adjunctive materials for lectures, made of this might be helpful, but would probably embarrass most teachers.

2.3 MAGNET BOARDS

Magnet boards are for some reason more attractive than felt boards, and pieces can be pushed around them as well as attached and detached. Moreover, the repellence of like poles can be used to advantage in manipulable models: the student can be asked to make the right connections among different pieces (say, in an electrical circuit), and the alternatives reduced so that incorrect connectors will push each other apart.

2.4 The FLIPTYCH

I have coined the term "Fliptych" for a portable study carrel whose sides are filled with printed texts and picture panoramas, and whose many pages can be flipped (actually, turned) like those of a book.

This would be a plastic object made of durable folding substance, which in its folded condition may be carried like an artist's portfolio; erected, it surrounds the pupil from forty-five to ninety degrees, and is practically over his head, as well. Around the plastic carrel are various pieces of mounting hardware (or integral prongs and sockets) to which attach large spiral-bound books of heavy paper or cardboard. Three to five such books are mounted simultaneously, and when opened they form a multi-paneled mosaic surround. Each would latch in open position, but in a way that permits easy page-turning.

Consider history materials for a fliptych. One book could be maps; another pictures; another documents and miscellany; a fourth, either more pictures or enrichment material, depending on the student's ability. Indeed, different books of text for students at different track levels could be used with the same pictorial material: this means that production costs for additional student tracks would be comparatively low.

Some editorial arrangements would be within a given book; others would involve effects spreading from book to book. There would be some coordination problems, but I believe the solutions are easy.

This object would be a privilege to use, affording privacy, vividness, interesting material, manipulation, self-pacing, and control of the environment.

It could evolve: the teacher would begin by handing the pupil a component book, and gradually expand him from there, letting him into the carrel to view the materials together.

Note, too, that the carrel could be expanded from a minimum configuration (say, three panels) to a very large one(seven panels).

Moreover, the variety of component books could give it an unusual fluidity: some of the same books could be used several times over in different grades, by changing their contexts.

If it were desired that the pupil study carefully, various "check tasks" could be scattered around the work in disguised ways, to see what he has done. But this scheme might also work against the properly informal absorption of ideas from the surround. Perhaps the use of the Flyptych should *not* be checked, and if it is highly desired by the pupils we may judge that it is doing its job.

(It could be augmented by audio, filmstrip viewer, projections, etc., at much greater cost; at less cost it could have scroll cranks and electrical test-givers; at any rate, none of these will be discussed here.)

It might be particularly suited to purpils of below-average interest and ability. Whether it would have any lasting beneficial effects on such students I do not know.

I would like to see such a thing contain a "book of extras" -- enrichment materials *dis*coordinated from the other materials, to enlarge the associative tissue the pupil can think about.

3.0 DECKS OF CARDS; AND OTHER LOW-ORDER MECHANISMS

3.1 DECKS OF CARDS can be useful for student review (as, for instance, vocabulary cards, or, on a more spectacular level, baseball trading cards -- whose potency cannot unfortunately be transferred to curricular material).

Decks of cards can also serve as a quick-access reference device; but they possess few advantages over a thumb indexed book, save perhaps that a few cards may be abstracted and carried elsewhere easily. They can also be easily randomized for review.

3.2 PRINTED SLIDE RULES AND WHEEL DEVICES ("circular slide rules").

People like to fiddle with these things, whether to calculate roofing costs, look up distances between places, or plan investments. Usually such devices only present the contents of tables that could be much more easily printed on a single page; but they may be less prone to error through misreading, and they are fun to manipulate.

Their use for multiplication tables is discouraged by schools; but as a review device, for historical dates and so forth, they may have a point. ("Verb wheels," giving verb conjugations for different classes of verbs in the languages we teach, apparently sell steadily.)

3.3 PEEKABOO REFERENCE CARDS.

The peekaboo system is a rather clever scheme for cross-indexing and especially coordinate indexing -- that is, finding documents or things that have several properties together. Though other cards will do, consider the IBM card, which has positions for 960 possible holes. We may in one such file index 960 possible documents.

Let each possible hole stand for a document, according to a numbered list. The IBM cards stand for properties. To tell the system that a certain document has nine particular properties, take the nine cards standing for those particular properties and punch them all through the hole position representing that document. When you have done this for all documents and all relevant properties, there will be as many holes as the properties you found in all the documents.

Now, to find items having certain properties in common, merely stack up all the cards representing these properties, and look through the stack. Where the light shines through are desired documents: documents that have all the relevant properties together.

Besides IBM cards, which some people find convenient, a card called Termatrex -- about a foot square, and made of plastic -- is also used for Peekaboo storage and searching. Termatrex equipment recognizes 10,000 different hole positions per card, and Termatrex drilling equipment goes through a whole stack quickly. The system is especially suited to medical research, with each position representing a patient and each card representing a symptom.

A similar system (probably smaller, and perhaps using cards the size of playing cards) might be suitable as a reference unit for a subject like geography. The advantage would be ease in looking up things having a given collection of properties. Disadvantages would be high production cost and ease of losing property cards. A deeper problem is the question of whether such a reference would be put to any use. My suspicion is that use of such an object -- aside from the delight of manipulation and mastery of it -- would be for general orientational purposes; and general orientation may be served better by handsome books of maps and pictures.

I know of one subject field where such a deck might be appreciated: this is Murdock's anthropological coding of the Human Relations Area File. A Peekaboo deck would permit the social-studies teacher to get quick answers to such questions as "How many of the world's cultures have feminine circumcision, couvade, a youth house and formal age-grading?" But it is doubtful that this would be wanted in secondary schools; quite the contrary. There would be a college market, though.

There is also a Minitrex system, which is the microfilm equivalent of Termatrex for large-volume applications. It is of no interest here.

4.0 GAMES (and/or "SIMULATIONS")

An excellent pedagogical advancement is the discovery that games can teach. (It has been obvious for centuries, but never mind.) Research by Coleman, and the subsequent development of such materials as the "Life Careers Game" by Boocock, indicate that the game can raise both motivation and understanding greatly in a realistic situation. The Life Careers Game, for example, presents a committee of pupils with the task of making important life decisions for a fictitious person

their own age. The decisions include what courses to take in school, whether to drop out, whether to apply for a job (and lifelike forms must be filled out, and lifelike chances determine whether you get it), whether to marry, whether to try to have a baby (if married), whether to apply for college, and how to spend time. The game hammers home the value of education in a credible fashion (exaggeration would annoy), and painlessly imparts the lessons of a few Hard Knocks. Other games under development include games about Congress, the U.N., and "community action."

Teaching games have a number of excellent features (pointed out at the Educational Realities Conference): 1) they are in a fun format, 2) they are not, unlike so many other methods, a new way for the uppermost to excel, but rather they open new avenues of achievement; 3) pupils soak up facts suddenly, rather than laboriously, 4) the teacher's role becomes one of help rather than reward-controlling authority.

Games under development for teaching purposes tend to be multi-person games in a structured but open, discussive situation. They usually involve the player's manipulation of various resources and being in various positions, but the games also allow considerable leeway for personal interaction and discussion. At their best they a) give insight into some situation or thing in the real world and b) build skills in the "impersonal complexities of cooperative negotiation" (Martin Gordon).

The design of games is not as easy as it looks. Like writing computer programs or teaching programs, overall intentions Snag repeatedly on minute detail. It may be, however, that new mathematics -- in particular, the theory of graphs -- may speed up the creation of games having certain foci and properties. This remains to be seen.

There are various problems with the educational use of games. The first is the word itself, which may have to be supplanted or helped along by such phrases as "simulations," "strategic simulations," "interpersonal simulations," "life simulations," "environmental simulations," "complex field simulations," etc. But of course these are pure euphemisms; intending to reinstate what rightfully should be the connotations of the word "game."

A problem I encountered myself, when I tried using the game of Diplomacy with my Vassar courses, was a considerable resistance from the students. They felt I was undermining their cool. (This objection would be no less for high-school or grade-school students.) Once play began, of course, there was no problem and they were swept away.

Whithin the context of primary and secondary education, though, there are a number of serious problems in the gaming approach. One is that individual games are not likely to mesh well with ordinary course materials. A related problem is that of introducing games firmly and confidently into the pedagogical stream. Lastly, the games must be adapted to the 55-minute hour (less announcements) and play that can only occur in intermittent class periods.

I have a straightforward suggestion: design the courses around the games. (Call them "simulation courses;" if they are in the social studies, as we must presume they shall be, call them"social simulation courses.")

The two courses suggested are to have the following features:

1) They can be taught in the 8th, 9th and 10th grades, depending on the enrichment material in the reading and the complexity of rules chosen;

2) The game format alternates with the class format, and one to two sessions

a week, at the teacher's discretion, are expected to consist of gaming;

3) The games are planned as a closely related family, so that the rules of each game are related to the rules of the one that came before, and entities in one game (e.g., "The President," "The United States") may figure, in a slightly changed role, in the next one.

- FIRST SOCIAL SIMULATION COURSE(abstract and contemporary.)

This course begins with individuals and works its way on out to international affairs: life careers game; poverty and civil rights game; civic adminstration game; Congressional game; Presidential Game; United Nations Game; Dictatorial Country Game (to show men of good will strive cunningly to effect the slow democratization of their country); Underdeveloped Country game (begins with the presence of a European power; various players seek independence or domination; situation can develop toward dictatorship, guerrilla war, U.S. intervention); Disarmament/Nuclear Diplomacy Game, presenting the problems of nuclear proliferation, disarmament and arms control in the presence of such trends as deterrence, escalation and nuclear blackmail.

These games will all have the following in common: a rich number of playing entities,

whose "personalities" are given by a common historical document, and whose Reward Structure is likewise explained in a common document; certain resources with which to bargain; the opportunity to make coalitions and exert pressures; a chance machine that enters at certain squeeze plays; and a special kind of chance card. These special chance cards enhance the parts to the pupils who must play them, privately revealing fictitious, chance historical reasons for them to be embittered, loyal, take certain kinds of action, and so on. This encourages the player to throw himself into interpretation. Finally, when the game is over, the group discusses the play, so that players may explain (in terms of both the documentary history and the special cards he secretly received) why he did what he did. The class can comment on the appropriateness of game moves, thus diffusing the idea of "winning" and "losing" by other criteria. The histories, special chance cards and discussion are intended to help pupils understand all different parties in the real-life situations these games describe.
The course material proper is factual, showing concrete cases.

SECOND SOCIAL SIMULATION COURSE (historical)

This course deals with historical events; its games should be chosen for variety and continuity. They might include: a struggle between empires; a struggle among political factions; an attempt to consolidate a regime; a revolution; a stage of the industrial revolution; a great war.

The game is played first; then a concrete historical situation is examined, and compared (in class discussion) with the games. Resources, coalitions and strategy can be compared with the turns of the game, and thus the real history may be better understood.

5.0 PROJECTOR SYSTEMS.

(Nice to combine with print technology, for mnemonic benefits of pictures)

5.1 OVERHEAD PROJECTORS

Overhead projectors have the special advantages that the teacher can face the student, can write on the slide or perform other manipulations on it, and be confident that nothing will jam.

Prepared materials for overhead projectors can be helpful to the teacher and graphically good, incorporating color and clear presentation of visual insights.

Possible manipulations with insightful visual impact include blackouts and revelations, sliding overlays, color overlays, and pieces of polarizing material. This polarizing material very carefully glued to the slide and projected through another polarizer, can give the illusion of circular or back-and-forth motion. This is called a "motion polarizer."

5.2. BALOPTICON PROJECTORS can project images of papers and some opaque objects. Should prepared materials be made for balopticons? An obvious reply is that the balopticon is for non-prepared materials, and if purchases are to be made the school might as well buy slides.

5.3. 3¼ by 4¼ PROJECTORS. These had little to recommend them until slide materials appeared for the Polaroid camera. Slide-in-a-minute systems are now possible. I can't think of anything to sell for them, though.

5.4 2 x 2 PROJECTORS. These are standard and fairly handy. Ordinarily they project slides made from a double-frame area of 35mm film; the picture is about 24 x 36 mm.

It would be possible to sell sides. However, the question of packaging/configuration presents grave difficulties. It would be possible to sell pre-filled projector cartridges; drawers in which the slides are fitted edgewise, where each slot must be labelled because the picture is invisible; or sorter sheets, which permit viewing of all the slides. Whether the sorter sheets could be illuminated so the working project~~ors~~ionist could choose among them is another problem, though.

5.4.1 TDC CARTRIDGE. This is a long box, moving lengthwise through the slide changer, holding about forty slides. (Boxes may pass through consecutively with the illusion of continuity.)

5.4.2 OTHER LONG-BOX CARTRIDGES

I believe both Brumberger and Gold-E sell, or did sell, rival boxlike projector cartridges.

5.4.3. The KODAK CAROUSEL SYSTEM is a line of projectors that take ring-shaped slide cartridges. These projectors have the advantage of being well-made and reliable; whether that makes up for the cost of the magazines and the difficulty of storing them is hard to say.

(Carousel models come in remote-control models, tape-synch models, and even (I believe) addressable models, but these will not be discussed here.)

5.4.4. ALL-CARTRIDGE COMPATIBLE 2X2 PROJECTORS are available, which take all types of slide magazines. This is of no particular advantage to anyone except the manufacturer and purchaser of the equipment. Note, though, that since the Carousel magazine is placed in such projectors vertically, the slides are presumably not in correct position for projection in an actual Carousel machine.

11.0 ADDRESSABLE PROJECTORS

11.1 TelePro Industries offers, for example, a remote-controlled double-barrelled addressable projector, in which you can not only select slides randomly, but you may fade them or make them flicker at will, and dissolve repeatedly from one projector to another in any slide sequence.

Of course this is much too expensive; but it presages many of the things that can be done with computer display, when that comes down in price.

11.2 IBM'S 1500 SLIDE CONSOLE.

One of the standard components in IBM's new 1500 teaching system is an addressable projector. It takes a 1000-frame 16mm single-frame strip of film, and can project any frame on demand.

(Why, considering the storage capacity of the medium, did they stop at 1000? A standard 100-foot reel of 16mm holds 4,000 frames.)

[Several addressable microfilm viewers are listed with microfilm systems (q.v.). From an optical point of view, they are projectors; however, they all employ rear projection through a translucent screen and are intended for one viewer at a time. It is entirely possible, though, that these addressability schemes and materials could be put into front-projection devices for group viewing.]

6.0 PLAIN AUDIO DEVICES.

"Audio" refers to analog signals in the audible range -- say, 40 to 15,000 cycles per second.

Audio components are of various types. There are microphones, loudspeakers, amplifiers, recorders, and what might be called "audio processors" -- for example, delay lines to give an echo effect.

Recording media are basically of three kinds: mechanical (creating a groove of varying depth, shape or position), optical (creating a visible trace of varying darkness or width), and magnetic (creating a trace of alternating magnetic domains on an iron or cobalt medium).

The original mechanical recording medium, the slightly tapering hard wax cylinder, has fallen into disuse. Its drum shape has been preserved in two forms of looped plastic belt: the Dictaphone belt (about four inches from roller to roller, and four inches broad) and the Walkie-Recordall belt (about and two inches broad). I do not know the speed of either. Belt media of course have the advantage (over strip and tape media) of permitting the listener quickly to skip from place to place. These plastic belts have in addition the advantage of great cheapness: a belt for either costs less than a dime. In storage they are safe from transient magnetic fields, but can be ruined by heat. They have very little fidelity. The Dictaphone belt will go perhaps half an hour, the Walkie-Recordall belt for two hours at "slow" speed (it can also be turned inside-out and used again.) The Walkie-Recordall is the standard police interrogation recorder, and apparently its mechanical recording is accorded a legal weight that is denied to tape recordings, even though undetectable forgeries could be made on tape and transferred to it.

The other form of mechanical recording is on disks. Early Victrola standardization settled on the speeds of 78 and 33 rpm; however, the latter speed fell into disuse because it sounded terrible. In 1948 Columbia reinstated the 33(1/3) speed, with high-quality fine-groove recording on a vinylite disk; RCA, repudiating its 33 rpm Victrola past, made a counter-innovation of 45 rpm on a seven-inch record with an inch-and-a-quarter (?) hole in the middle. They were correct in claiming that 33 rpm was not quite fast enough for full fidelity, and that the record area toward the center was not fit to record on, but it was too late.

At the present writing, 78 rpm has fallen into disuse, 33 is standard for most purposes, and 45 is standard for popular music. What has happened to a recent cult insisting on 12" diameter and 45 rpm I do not know, but such records were made.

Optical recording is used chiefly for motion pictures, to my knowledge, and in recent years its use there has been virtually confined to release prints, except when used for visual synchronization purposes. It occupies a narrow band on the edge of 16 mm or 35mm film. Its speed in 16mm is thirty-six feet per minute, and more than twice that in 35. Its frequency response is poor, though schemes exist for improving it. Multiple ("stereophonic") tracks on motion-picture film are usually magnetic.

There is one form of optical recording on a circulating medium; I believe it is a drum, but it might be a disk. It is a small proprietary device for spoken replies by a computer, made by a small company (name not now in hand). It can make only a dozen or so short speeches (of a few seconds) under electrical triggering.

Optical sound from wide tapes -- say, eight-inch or foot-wide widths of celluloid -- is now a widely used means of experimentation with sound, though I know of no commercial equipment for it. Using paint or opaque tape, the experimenter creates an opaque pattern on the band; it is then passed through a reading device which interprets it as a sound spectrogram (high frequencies played by marks at the top, low frequencies by marks at the bottom.) An interesting fact is that quite acceptable speech -- peculiarly toneless and mellifluous -- can be created by simple designs of lines whose approximation to the long cloud of the human sound spectrogram seems remote. I understand that this technique originated in Sweden: it is now used (e.g.) at Haskins Labs in New York and IBM/San Jose.

Magnetic recording is used for a host of purposes today; it is possible to obtain ¼" tape recorders at prices from five to five thousand dollars. While there is considerable standardization, I believe it is shaky.

Originally, I believe, magnetic recording was standardized in speed at 60 inches per second; this was in the thirties, when they recorded on steel, and the reels were a yard across and weighed a ton. As improved recording media and heads were developed, speed could be reduced while maintaining or improving fidelity. Thus the convention began of standardizing tape speeds by successive halves of 60 inches per second. Standard speeds are therefore 60 inches per second (scientific only), 30 ips(rare), 15 ips (professional), 7½ ips (serious amateur), 3 3/4 ips (amateur), 1 7/8 ips (formerly talking books, I believe, now other amateur), and 15/16 ips (rare). The only exceptions I know to this successive-halves rule are an off-speed around 2.3 or 2.5 ips (Grundig dictation machines) and the bizarre fraction of

15/160 ips (earthquake recording; one tenth of the next slowest speed).

While standard width is ¼", half-inch, one-inch and two-inch tapes are in use, as well as sprocketed movie film.

Track positions on standard magnetic tape are only partly standard. Originally recording took place across the full width of the tape; now this is called "full track." Half track recording, was the next step; it permitted a reel to be turned over and used the other way, but discouraged tape editing. As it became possible to make fair recordings on narrower and narrower trails, the number of tracks has grown. Since half-track, however, there has been little use of all these different tracks for separate materials, but rather the growth of two-track stereo and more recently four-track stereo.

I believe all these layouts follow this rule: if the tape is shiny side toward you and moving toward your right, the track at the top edge is playing. If there are more than two tracks, the others which are playing are third down, fifth and seventh.

An irksome exception, again, is the Grundig dictation system, which uses the other of the two normal tracks (lower as you watch it), and so can only be heard backward on a normal tape machine.

Audio recording is also made on sprocketed magnetic film, either 16mm or 35mm. Several different high-fidelity tracks can be recorded on this medium at once. Because of the sprocket holes, it can be exactly timed and synchronized; indeed, its contents can be made precisely addressable in a searching system. (The other ways of creating addressable magnetic tape are a) to set aside a special "marker" track, which will beep at all the important places, or b) stick on a piece of reflective foil and find it with a photoelectric cell.)

The IBM 7770 Audio Response Unit is the only magnetic disk audio system I know of offhand. As I understand it, this is a mechanical brother of one of IBM's ordinary disk-file systems; except that the information is not recorded as digital characters, but as plain audio. The disks revolve more slowly than the digital disk file, only a few times per second, but even at slow speeds the machine uses a huge amount of real estate to hold a few recorded words. (I believe it holds up to 128.) The words are digitally addressable, of course, and if properly timed the machine can comprise them into stilted-sounding "sentences." The unit is expensive, though, and the whole approach seems like shooting mice with a howitzer.

Magnetic belt systems. There is at least one recording system that uses a continuous magnetic belt; this is IBM's dictation-machine system. The belts are re-usable; this is about their only advantage, since they are much more expensive than the mechanical plastic belts, about the same size, used by Dictaphone. The units are also remarkably overpriced; the small pocket model, for example, costs some $450. The quick backspace available with belts, and I suppose a luxurious degree of fidelity and styling, are the main advantages.

I doubt that IBM has any corner

on the magnetic-belt idea, though, and because of its potentialities of addressability, low cost, and the mixing of audio and digital information, this basic idea (if not IBM's dictation belts) seems a strong candidate for desk-top digitals (q.v.)

6.1. JUKE BOXES.

A juke box is an addressable audio disk memory, usually with a rudimentary queuing feature. The old ones that took 10" and 12" records are now rare; the 7" and 45 rpm disc is standard.

It might be possible to use a juke box in schools to allow individuals to listen to language lessons, recorded lectures and great speeches. The possibility is not worth considering, however.

6.2.1. ADDRESSABLE AUDIO TAPES can be used to present by ear programmed instruction (q.v.) The chief good thing about this is that it leaves the hand free.

6.2.2. SPEECH COMPRESSION at the same pitch -- so that people talk faster in a normal tone -- was formerly possible only through sophisticated electronic techniques (single-sideband heterodyning, for instance). However, a recently demonstrated system accomplishes this by rapidly scanning the tape, with a moving head, permitting speedup at normal speech frequency. Faster talking saves a lot of time. Where recorded lessons of a discursive, non-punctilious sort are to be played by the student, such speedup would save his time.

Apparently pedagogues worried that compressed speech would be unintelligible or frightening. Clearly none of them listen to Station WABC, where the disk jockeys talk very fast and nobody complains. Frankly, I think that instead of being mechanically sped up, people who make tapes should be taught to talk faster. Indeed, a large school system could save a year every day if the teachers talked faster. It would also reduce the boredom of school; unfortunately, one of the ways some teachers learn to get along is to speak more slowly and and rhythmically when threatened. I am sure this only makes everything worse, turning all present to woolgathering.

6.2.3. INDIVIDUAL USE OF DICTATING MACHINE

Hearing yourself speak is like seeing your own profile: it startles, causes disbelief, and can produce untoward emotional reactions. However, if we saw our profiles often enough, we would stand straighter.

In the teaching of English, perhaps the hardest thing to fight is the fact that ordinary communication takes place with many um's, er's, vague gestures, and incomplete sentences. It follows that someone who is going to learn to speak or write the grand English must learn to listen to himself. It might be profitable to place students at dictation machines, and require that they record connected narratives in complete sentences without um's. (My best lesson in public speaking came from a professor who could stand still in mid-sentence for twenty seconds without saying "uh...." Every listener is poised attentively, it seems, until the speaker says "uh," at which time they slump, never to rise. Never say "uh," never lose attention.) Dictation machines are a step in the right direction.

6.2.4. LANGUAGE LAB CARREL

6.2.4. LANGUAGE LAB CARREL

Apparently the language lab is a relative failure; it would be nice to know why.

I suspect it was in the transition from requirement to adjunct. In part this was a consequence of the self-scheduling required; but one of the most valuable features of classroom teaching systems, the inexorable commitment of time without effort or conflict, could not be transferred to "adjunct" status. Repetitive material with no strong organization or natural stopping place throws off students like a bucking bronco.

6.2.5. DIAL-ACCESS AUDIO TAPES

The remarks immediately above, about the commitment of time, apply to dial-access systems in which the weight of the system does not sweep the student into the carrel. Unless it is an excitement and a privilege to be there, or there is no way out, he will find it intolerable.

Since individual tape machines become cheaper and cheaper but dial-access switching crossbars do not -- Western Electric has had the costs way down for a long time now -- there does not seem to be much advantage to the dial-access system except avoidance of mischief. A loaned tape can have amendments playfully added, etc. (However, not having recording facilities on loaned unites is one solutuion.) The assumption that students cannot thread tapes, already dubious, crumbles before the ease of teaching someone how or the simplicity of using cartridge tapes.

In other words, dial-access audio -- except for shut-ins or remote locations -- has only dubious advantages.

6.2.6. TAKE-HOME TAPE RECORDER FOR LANGUAGE PRACTICE

It has been suggested that it would be an advantage for the student to be able to take the equivalent of a language-lab console into the privacy of his own home.

I am certain this is incorrect, and such an expenditure of equipment would simply abuse a lot of electronics. Work is not welcome in the student's home, and the customary things that make it tolerable -- the sense of something accomplished or completed, a unit done, something under your belt -- do not, I think, come neatly from this sort of practice. The only way to measure the passing minutes is on the face of a clock, not by benchmarks of accomplishment. For this reason it is simply an attempt to pre-empt the student's "free" time, and in a direction where lies no hope.

6.2.7. LOOP TAPE RECORDERS

These are of no particular interest.

Repetition is, of course, used in various audio lessons from language-teaching to electric guitar, but a tape loop really requires no special equipment.

6.2.8. TRIGGERED AUDIO ANNUNCIATORS

(that go off when a certain thing happens)

Systems of this kind are especially useful in exhibits and pavilions, q.v.

6.2.9. SHORT-RANGE RADIO (no license)

This may have a number of uses, but probably few that tie in with publishing. The FM "wireless mike," actually a short-range transmitter, is tiny and high in fidelity; of possible use in lectures and demonstrations where the instructor wishes to hop about a lot.

Short-range receivers are being used in museums and exhibits as a substitute for a guide: in one scheme, the receiver receives a continuous loop as it nears appropriate displays; in another, the receiver gets a long unbroken program, and the people carrying it are supposed to go from exhibit to exhibit in the correct sequence. Obviously, if they become lost or out of sequence the results are unfortunate.

Transmitting to particular students at separate desks might have some points, but it is really just a more expensive system of earphone communication.

7.0 TEACHING MACHINES, "PROGRAMMED EDUCATION"

Of course we know that teaching machines present only what is put into them, and do so in the way they are supposed to. Consider then the different types of teaching program: Skinnerian or linear, in which the subject's response in no way alters the future presentations that are set up for him; bridging, where his response may enable him to skip a long sequence that lay in wait; and branching, where many sequences are waiting, and what the subject does determines his path. All are boring, but the linear type is the most dismal.

According to traditional (eclectic) learning theory, the student's **correct responses are being reinforced,** and conditioned associations are growing between the situation (immersion in a certain subject, specific questions, phrases and images) and the student's response (propensity to utter correct answers,do the right thing). Theoretical psychologists have repeatedly stressed that much of the technical advantage of programmed learning is in the prior specification of "correct target behavior." If we specify the target behavior exactly we can "shape it" to a nicety with presentation/reinforcement sequences. That is the theory.

However, cynics like Robert F. Mager have pointed out that if you simply state the target behavior clearly to the subject he can arrange to learn it more efficiently on his own. And the "target behavior" supposedly "evoked" by a course in history turns out to be a very forced description indeed, one that could be much more easily stated in terms of knowledge and understanding of specific topics.

In other words, the theory of programmed learning is irrelevant to what actually happens. What actually happens is that students are paced slowly through boring workbooks. They have one effective feature: The commitment of time is semi-automatic; as long as you sit there, what else is there to do? It works, after a fashion; those that finish learn. But even zealots are beginning to reverse the earlier claim that it increased motivation.

My theory is this: it reduces anxiety, clears frills out of the syllabus and promises that if you can stand to push through such a boring sequence of activities, you will have learned something. The user decides for himself whether it's worth it.

So much for the psychology of it. Why people will or won't buy it for schools is another matter, a sociological one. I don't think it's hard to predict that the present trend will continue: programmed texts will be bought as adjunct materials but not for the core of the course. This is because the teacher (or responsible purchaser) is placed in a doubly awkward position in committing completely to a programmed teaching setup: first, he is sticking his neck out and placing the burden of teaching outside his control, in people he can find no reason to trust; and at the same time, he is acting against his self-image as an explainer, a boatman across the dark river of his subject. School boards are likely to see it the same way. For these reasons, I think programmed learning will spread and spread as a way of presenting less important parts of the school courses. If this is so, what teaching programs are adopted may be a barometer of what courses or requirements will eventually be dropped.

Low-level machinery for "programmed education" will not be discussed here.

8.0 REPRODUCTION SYSTEMS

8.1. XEROGRAPHY

At first blush it would seem like an exciting possibility that the Xerox machine could find some application in the classroom -- duplicating "enrichment" materials from a central file, for instance.

However, the studey of reproduction methods in schools by the National

Opinion Research Center found not a single Xerox machine in any of the schools studied. Schools are poor, fundwise. And unfortunately the other brands of copier are less versatile and attractive.

However, let me mention a possibility for the future. It might be of interest to prepare materials for Xerox mosaics -- small bits of illustration, prepared chunks of text, that a teacher could quickly throw together and copy They might be self-adhesive and removable; at any rate they could be assembled fast. Tasks like writing out the derivation of the quadratic equation or the families of verb ending in Spanish would be no trouble, since these would be all printed up.

A curious point is that because Xerography is more sensitive to edges than to solid black, an all-black square area will look when Xeroxed like a black frame with the center shading toward white. To adapt pictures to the Xerox mosaic medium would probably mean discovering artwork principles yet unknown with regard to light and shading.

9.0 MICROFILM (exclusive of microfiche)

Microfilm shows its parentage in its standard widths: 16mm, 35mm, 75mm, 105 mm. But the sprocket holes of movie film are gone. Suprisingly, microfilm as sharp as today's ordinary emulsions was used as early as 1828. But packaging and convenience machinery -- new non-scratching film movements, in particular -- have been developed more recently.

Microfilm is in some contexts very cheap, in others not. The microfilm flow camera allows unbound sheets, cards and so on to zip past a lens on a cylinder or a belt. Costs of this method are negligible, say, a penny per document. Planetary cameras, which photograph whatever's upon under them -- i.e., bound books and full newpaper sheets -- are a different story: the cost of this photography is at least ten cents a shot, and much more in the greater widths.

Microfilm is ordinarily kept on a roll, which is cranked through a viewing projector when you need to look at a part. However, sometimes it is cut up and put into jackets, which give it a card-like format.

9.1. ADDRESSABLE MICROFILM (strips)

9.1.1. The main addressable microfilm is Kodak's Miracode. In the Miracode system, each document is photographed with accessory information, in the form of large light-colored streaks or blobs next to it. Such a roll can be machine searche, and the viewer's film drive will stop when it reaches that point. (Instead of a takeup reel the Miracode machine stuffs all bypassed footage into a tumble box -- a shallow drawer. I do not know the advantages of this.

Miracode microfilm is ordinarily packaged in boxlike cartridges that fit in your hand and hold the standard 100 feet. It is also now being set up in strips of a foot or so, to be kept skewered into a cabinet and swiftly accessible.

Advantage of Miracode: addressability. Disadvantage: high cost of putting on the code; possible irregularities resulting from the fact that the system permits the same code to occur several times on the one roll; many fewer documents per roll because of the space required for the coding.

However, this is one of the few addressable projectors that use a strip of film rather than slides; it might be re-engineered for use by teachers (during question periods, for instance) permitting fast selection of illustrations to accompany answers or discussion.

9.1.2. Bell and Howell offers another cartridge system. This has a takeup core in the cartridge. I do not know how it works.

9.2.1. A new IBM system -- the "Model 1350 Film Storage Device" -- uses 35mm motion picture film in short lengths (I believe about three inches) with a magnetic stripe on which digital information is written.

I am not sure how this relates to IBM's WALNUT system, sold principally to the CIA. WALNUT is an optical system, and used strips of film in cartridges radially disposed about some central copying mechanism. (WALNUT's radial cartridges have been imitated in IBM's new 2311 "data cell" mass storage unit.)

9.2.2. The Magnavox "Media" system

uses a metal cassette with addressable film chips. The film chips are addressable by optical markings, and, like Miracode, give up much of their space to addressing.

9.2. MICROCHIP

Eastman Kodak has a much smaller micro-medium, of a width like that of shoelaces and length of perhaps an inch, which is sorted automatically by spindles running through holes under some form of digital addressing.

I am under the impression that this has been employed chiefly in secret government applications, though it was openly described once in a Scientific American ad.

9.4. MICROFICHE

Microfiche means little card.
A federal standard exists, making the standard microfiche film card 4 by 6 inches, and making it translucent.

9.4.1. However, IBM has just committed itself to another standard microfiche for all purposes. Its size, by coincidence, is that of the IBM card.

9.4.2. EXTREME REDUCTION MICROFICHE

Two other microfiche systems have appeared lately, both offering extreme reductions (on the order of 160 to 1, instead of 16 to 1).

The National Cash Register Corporation offers a manual system at this great reduction (they have put the Bible on a single card). Their selling point is the use, in making masters, of Photochromic micro-images (q.v.) Their technique assures high image quality.

Fairchild-Hiller Corporation is offering addressability on a single microfiche, together with touch control of motion. The user can either select the frame number, among thousands on the card, and send the machine to it, or drive the machine there himself by pushbuttons that move the card slowly.

Two features of such extreme reductions deserve notice. One is that the images always look slightly blurred. Another is a slight granular rainbow speckling. I have observed this on the Fairchild Hiller machine, at any rate, and I warrant that it comes from extreme magnification effects involved with the actual wavelength of light. This may be wrong, though, and it may just be the groundglass screen.

9.5. OPAQUE MICROCARD. This is fairly inexpensive, about the same as microfiche, but because the light must be reflected a viewer needs a brighter bulb, bigger housing, more cooling fins. At any rate the federal government passed it by in setting standards. I believe that the nearest thing to a standard was the 3x5 card promulgated by the Microcard Corporation. This had the advantage of actually fitting in standard library trays; it would be possible, though perhaps confusing, to put the whole books, rather than just their names and locations, in the trays.

MICROTAPE deserves interest in this context. It is the trade name for opaque prints of roll microfilm made on a long gummed tape. This is cheap, about 10¢ a foot, it requires only ordinary roll microfilm equipment, and allows the user to work out his own filing scheme.

9.6. APERTURE CARD.

The aperture card, developed during World War II for the OSS, is simply an ordinary Hollerith (IBM) card with a picture transparency mounted in a hole in it. Ordinarily this transparency is mounted about in the center of the righthand half, and is slightly larger than an inch and a half square, being cut from sprocketless microfilm.

This form has several advantages. The picture itself is not handled too much, and punchcard designations, like the picture itself, can be duplicated automatically. Moreover, it can be run through conventional tabulating equipment, thus automatically being put in numerical order or alphabetical order, or sorted according to indexed content. Unfortunately this advantage is usually overriden by the damage that the pictures are liable to suffer from the contact brushes, transportation belts and so on within the machines. Thus the IBM feature is in many installations merely a hangover. Modifying the machines may reduce damage, however.

However, this medium is flourishing, being especially popular in architectural many individual drawings exist and they may succeed one another at a rapid pace.

¶ Although there are 16mm aperture cards on the market, as a vehicle for multiple pictures they are obviously inferior to microfiche.

10.0 ODD OBJECTS

10.1 TAKEAPART MODELS WITH STRUCTURE EMPHASIZED.

Why must students dissect real frogs? In seven cases out of ten, wouldn't they get more out of dissecting artificial frogs specially made for the purpose?

10.2. TEACHER'S PROGRAM FURNITURE AND PICTURES FOR IT

Teachers are today edgy and embarassed, with reason, at the slides and projectors they have to work with. They have little control. They don't know what is happening.

However, it would be possible to build a projector inside a lectern -- let's call it a Projectern -- pointing whichever way is appropriate, and give the teacher a choice, from an illuminated board of pictures, which one he will show next. (This is like selling slide sorters, except without the fumbling.) This would have to be accomplished by a microfilm, microfiche or cassette approach. It would require new hardware development. Things to think about would be addressability, multiple screens, teacher's preview. Perhaps, as in the Panacolor movie cartridge, parallel program tracks could be used.

Sociologically such a system puts the teacher where he wants to be: at the center of the information flow, in control of the information and presentation, and in a position for all sorts of personalization. How he could remain in control of it would be the main problem: perhaps on top there could be a spiral-bound notebook with buttons coming through holes. With each turn of the page the buttons would mean something new, and call to the screen the illustration now above it. (We could take it a bit farther and write the lecture for him or give him many enjoyable alternatives.)

11.1 LENTICULAR PRINTING is the printing of several different half-tone images beneath a sort of corduroy plastic, so that the light reflected from each picture passes out at a different angle.

9.4.3. AN ADDRESSABLE MULTI-MICROFICHE unit has lately appeared, made by Houston Fearless. This has the advantage of keeping all originals within the system and (conceivably)out of mischief.

The cards are arranged internally by decks in slots of a Lazy Susan, and picked off by rods through a punched or notched coding scheme.

The advantages of this are hard to assess. Microfilm is by quantity cheaper; the particular advantages of microfiche is that units or sections may be swiftly changed, and one person does not tie up a whole file. If they are all to be locked in a box then the first of these advantages is diminished and the second abolished.

In suitably posed pictures, and with the ribs running vertically, a fair illusion of three dimensions is achieved if your head is in the right position. Depending upon the position of your head, however, about half the time there will be ghost images as well.

The same technique may also be used for motion, especially cycical or "dissolve" motion in one-frame animated drawings. It is used for this on cheap gewgaws, especially plastic pencil sharpeners and key-chain fobs.

I'm not completely sure about this, but I fear the sleazy quality of such objects might detract from them for most purposes. However, a lenticular 3-d four-color cover might be considered, say, for a science book series -- where excesses are pardonable if they have a technical side.

11.2 3-D VIEWER WALLS. Using plastic strips molded with many lenses, and putting color motion-picture film behind them, it would be possible to build a "viewer wall" containing thousands of three-dimensional pictures. (Note that the problem of interocular distance may be soluble.) This might be an interesting come-on for various kinds of activity, but would not have enough "quality" to be created as a thing in itself.

12.0 ODD OPTO-MECHANICAL EQUIPMENTS

12.1 HAND-CRANK PROGRAMMED SLIDE VIEWER.

This would be a modified movie editor intended for looking at single frames under the direction of a master sequence (q.v.). It would probably use magnetically striped movie film (carrying digital information in the stripe), and it would branch according to the desire of the user or the man who wrote the program.

The student would have several choices of button to push, and the machine would examine his choice. A light would light on his left if he was to hand-crank to the left, on his right if he was supposed to hand-crank to the right. As he began to crank a shutter would drop; if he passed the frame the opposite light would go on; when he stopped at the frame a shutter would go up.

A system like this would improve programmed education quite a bit by adding pictures. It would also be a good system on which to follow out personal interests, if the creators of materials wanted.

The machine might cost as little as a hundred dollars in quantity, two years from now. Whether it's desirable is another matter.

13.0 SMALL DIGITAL MACHINES

Digital machines for various purposes are attractive-- as compound programmers and controllers, as calculators, communicators and simulators.

The operation and possible uses of large digital machines will be discussed later. In this section we will only discuss small machines that are possible.

First we should consider the question of whether it is worthwhile to build little "stand-alone" machines at all. The alternative is some kind of satellite arrangement around a large machine with a more capable central unit controlling the action of several (or many) keyboard devices, calculators, individual presentation-control arrangements, and so on. In several applications this is becoming popular. At least two desk-top electronic calculators, the Wyle Scientific and the Wang Laboratories LOCI-II, may be obtained with remote keyboards that have independent registers and readout. Control Data also makes available a calculator keyboard which connects by telephone to its larger computers.

In a like fashion, Digital Equipment Corporation has a special approach to the teaching of computer design. Instead of giving each student a separate small core memory, and letting him hook his own circuit logic to it experimentally-- an arrangement they sold before-- now they are offering separate "memory" terminals that each communicate with a section of the memory of a PDP-8, their smallest computer.

The reasoning behind these arrangements is straightforward. In each of these satellite systems, basic machine costs much more than the additional terminals, and so each share of work becomes less expensive.

13.1 SMALL GENERAL-PURPOSE COMPUTER.

It is possible to build small general-purpose computers having a very short word length, such as six bits. (One of these exists, the Fabri-Tek Bi-Tran Six, but it is greatly overpriced.) Four bits would be possible but strange; two bits is conceivable, but might be considered insane. Such a short-word machine, having a delay-line memory and operating inefficiently at microsecond speeds, could be built for a few thousand dollars. Conceivably less of a machine, but with vestiges of its "general" capacities and a magnetic belt or quarter-inch magnetic tape for memory, could be built for a few hundred dollars in quantity.

Such a unit would not be a good desk-top calculator, owing to the difficulty of readout; it would be best suited for use as a control box for audio-visual displays, especially for controlling an addressable tape recorder and/or addressable slide projector. But if suitably designed it could perform the bridging and branching functions possible now only with CAI terminals.

However, if this were the principal function of the device, considerable engineering could be saved by giving it less capacity.

13.2 CONTROL BOX.

A small desk-top digital processor may be constructed for the control of audio and projection equipment. This device could be of three types.

13.21 CONTROL BOX WITH SEQUENTIAL PRESENTATION, SEQUENTIAL STORAGE.

This could be used for programmed education of the Skinnerian type, or for audio-visual presentations under the control of the teacher or lecturer extraordinary. (See Teacher Control Unit, section .) It would make no exceptions to the prearranged sequence. One special advantage of this configuration is that it could use ordinary quarter-inch magnetic tape and need no other form of memory.

13.22 CONTROL BOX FOR BRANCHING SEQUENCES, WITH LINEAR STORAGE.

An elaboration of the design above would permit branching, but never backspace within the program structure that has been prearranged. The memory could still be an entirely serial medium, i.e. quarter-inch tape; however, when the machine arrived at a branch point, it would skip to the appropriate destination, which would be clearly addressable on the tape. This could still be very low in cost if speed of response were not essential-- if, say, an individual pupil watching a branching projection sequence (on such a device as the IBM 1512 16mm projection box), the control portion of this system could be quite inexpensive if the student could wait, say, five to fifteen seconds before the control box gave the next instruction, irrespective of the further lag of the display unit.

13.23 CONTROL BOX WITH ANY-WHICH-WAY BRANCHING. If essentially linear storage becomes impossible, or gradually impractical, an addressable memory of some sort becomes necessary, and costs will increase substantially. One possible inexpensive memory (for a control box which addresses, say, up to 2,000 presentation items in complex order) could employ one or two magnetic belts (of the type used in IBM dictation machines). Such a device should be able to respond in less than five seconds in most cases.

13.3 CONTROL BOXES WITH AUDIO.

Incorporation of audio in the above control boxes should be quite feasible. However, if audio segments occupied space in a belt system there would be less space, say, left for digital memory, and so the overall amount of memory-- number of belts and associated drive circuitry-- would be correspondingly increased.

A combination of quarter-inch tape and magnetic belt would of course expand the capacity of such a unit, but introduce buffering problems into the system; or, if it were desirable to backspace the quarter-inch tape, this could all be put in a very versatile system but at the cost of some bothersome engineering. If some accommodation were used that put audio on the quarter-inch medium, and digital information on the magnetic belt, or employed other sorts of simplifications, the engineering might not get out of hand. Since the IBM unit holds only a dozen or so minutes of audio information, program planners hoping to write materials for such a system will be quite cramped in the sorts of possibilities, especially in the sorts of interconnections, to which they are restricted.

13.5 LARGE DIGITAL MACHINES.

There is one digital machine being used chiefly as a control box for video, audio, and displays. This is the central processor of the IBM 1500 system, actually an IBM 1130 or 1800 computer.

Because this application is a part of their overall fabric of computer-assisted instruction, however, this machine will be treated principally under that heading.

14.0 MOVIES.

Motion pictures in their present form-- that is, using successive frames upon a long strip of plastic film-- date back to the 1880's. 35mm was the original size; 16mm came later. 8mm, I believe, came later still. The increasing quality of films (and special improvement of the smaller sizes) has resulted from better and better emulsions, better film movements, and sharper lenses.

Sizes. There are essentially three standard film sizes used on a theatrical basis: these are 16mm (used for education, religious organizations and company films), 35mm (used for release prints of commercial motion pictures), and for video, audio, and displays. This is the central processor of the IBM 1500 system, actually an IBM 1130 or 1800 computer.

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70mm (2 times 35), first introduced I believe in the 1930's, which is used for the finer wide-screen systems, notably Todd-AO. While 105mm (3 times 35) has been a standard in microfilm and aerial photography, I do not know whether there are any 105mm motion picture systems. (I am under the impression that the first-run system for the film "The Bible" may be 105mm.)

Other Variegations. Curiously enough, sprocket holes are not of a single standard. Apparently the design of sprockets and the corresponding sprocket holes is an extremely intricate business, hanging on various desiderata both in the finished film and its handling equipment. Though in each gauge there is a standard sprocketing for original camera use, there are various interesting exceptions, like high-speed, slow-motion cameras, which do not accept ordinary film. Furthermore, process and laboratory work may call for further non-standard sizes, systems and arrangements. The wind of a film is also important; films are wound with emulsion inside (A wind) or out (B wind). These have different purposes.

Techniques and styles. The available range of movie production techniques is scarcely grasped by most filmmakers, let alone employed. Film making in Hollywood since the 1930's has been standardized and stultified, with extraordinarily conventionalized restrictions upon the framing of the subject, the angle and the balance of lighting, the movement of actors, and the use of sound. It did not take the French "New Wave" to discover that there were other possibilities; there have been many American experiementers continually at work, with the baroque stylist Orson Welles only one. The innovations typical of Hollywood directors, of course, have more to do with the staging of fights, the use of trick props, and the construction of scripts; visual and aural innovation has been scarce until the recent influxes of the New Wave and the TV commercial.

If innovation in the commercial photoplay has been slow, ~~it~~ this slowness has been far more acute in the "educational" film. I attributed this in large part to the fact that the most talented people have gravitated toward the photoplay and the high budget production, leaving low budget "educational" items to those with less drive and imagination. The budgets of educational films, it is true, tend to be highly constricting, but the lack of funds has not prevented many wonderful achievements in the film-- right now I am thinking of Nanook of the North-- and large budgets may be thought of as a luxury, not a necessity. Moreover, the editing, use of sound, and narrative approaches conventionally employed in educational films have been execrable.

The 1962-3 World's Fair may well represent an important moment in non-fiction films. While multi-screen productions, particulary To Be Alive, rightly attracted a great deal of attention, a great deal of other film work was shown at the Fair which indicate to me that there is now in this country a large stock of competent, imaginative filmmakers ready to do better things.

What I am saying is that the problem of educational film quality is one not of the medium's restrictions, or of budgetary hamperments, but one of there not being enough people to make good films, except few and far between, until the present time.

All media are constrained by their environments, and the film is an obvious example. Different film structures are feasible, possible and indicated under different circumstances. An example is the program structure of the photoplay as it evolved in this century; initially the one-reel subject, about fourteen minutes in length, predominated. This may have been due to the character of the audience, the character of the theater, the structure of the working day, the nature of the client population--

which in the nickleodeon era consisted largely of poorer people-- or upon the psychological proclivities of the people who actually made movies. No doubt it was all of these things. The development of the feature-length photoplay clearly required the development of a differentiated client population, relatively sophisticated in the conventions of the cinema and drawn to the persons who appeared in it and the situations it depicted. But while the photoplay had an impetus of its own, a critical audience, and a well-oiled production and distribution system. The people who pay for educational films probably do not have to watch them, and the arrangements for seeing them, let alone tying them ~~in~~ in to curriculum, have been less than smooth (except perhaps where there exist weekly slots for showings). The pictures tend, I would guess, to be made-to-order rather than made for a reason-- at least a reason apparent to both makers and audience.

I think that the construction of educational movies to fit an explanatory or illustrative need, rather than a time slot, has been relatively recent.

It seems to me that movie systems-- presumably lattices and garlands of very vivid short film loops-- stand to be the most important publishing possibility here. In other words, not five or six loops, but several dozen, would be an opening wedge. With the larger stock the school could justify the viewer. But the problems of obtaining the best materials in this quantity are considerable.

CARTRIDGE MOVIES, ESPECIALLY CARTRIDGE 8.

Putting the films in cartridges has a deep sociological effect, and I think it quite unpredictable what forms of presentation will result. The cartridge permits any child to initiate his own presentation, stop it and change it at will.

The fact that the contained film is a loop has also strong implications for fine presentational sequence. In a loop film it is tacitly assumed that the user may easily sit through one and a half showings and/or come in in the "middle," if there is one. The fine sequence of presentation is itself no longer a lattice but a loop. The maker must concern himself with the presentational validity of a number of consecutive "points" as opposed to the validity of a presentational chain that has a beginning and end. Whether the term "single-concept" film is appropriate is arguable.

There are several questions involved in making cartridge 8mm films. The first is, naturally, the initial one of standardization. Since Super 8 seems certain to take over eventually, owing to its doubly good picture definition, "standard" 8 may be thought of as an interim stage. So much for the size of the film. The cartridge itself-- first the Fairchild and Technicolor machines, and now the forthcoming Kodak and Bell and Howell machines-- present more of a problem. Which ones will be compatible is obviously an open question. Whether a universal machine will soon embrace all cartridge sizes remains yet to be seen.

From the point of view of the producer or publisher of loop films, the question of program material is the critical one. The position of the films in the curriculum is obviously a difficult one to predict. Is it a rule that most technological aids to the educational process are first widely introduced as adjunct materials? In which case, should the loop film present the "core" concepts, or the "enrichment" material-- or both? Should the loop film concern itself with things which may be well presented statically? (But cannot anything be well presented statically by a good enough illustrator?)

15.3 MOVIES AND AUDIO.

To most people, "movies" implies audio, though the movies were thirty years old before they successfully talked. It should be noted also that sound in films has gone through many stages. The first, badly synchronized, hooked a phonograph record to the projector; then came the Vitaphone process, which linked an optical trace on one side of the film to the moving sprocketed film. Later came magnetic sound. This began with Cinerama, in the early 1950's, which I believe originally used a separate magnetic film, 35mm wide, with eight separate sound tracks, in synchronism with the three photographic strips. Cinemascope, which was developed by Twentieth-Century Fox as an answer to Cinerama, used a single strip of film again, but managed to place two magnetic stereo tracks on the film itself. Since the magnetic track has an intrinsically higher fidelity than the optical track, I believe this may have continued; though I believe it is also possible for installations which do not have magnetic sound to use an optical track with Cinemascope.

Lately sound has extended itself down into 8mm: first with the Fairchild magnetic sound system, later employed in their cartridge; and now with optical sound, recently announced.

15.31 SCOPITONE. The scopitone movie juke-box employs 16mm film loops, which I believe must be loaded by a technician and spliced in place. It has the disadvantage of non-changeability.

15.33 CARTRIDGE 8 JUKE BOX. Someone has recently packaged a juke box capable of playing Cartridge 8 films requested by the viewer. This machine is not perfected; it is very noisy as it changes films, and proved a failure. However, it has very good prospects, as the program may be changed by anyone at a moment's notice and program materials may be sent easily through the mail. However, it suffers in that its resolution, being 8mm, is intrinsically less than that of Scopitone, and the picture is simply nowhere near as good.

~~[illegible]~~

15.0 AUDIO AND SOLID OBJECTS

In this category we might put museum exhibits which can be made to "talk" by pressing a button; radio receivers or tape machines to be carried through museums, and having commentaries and sounds to go with the exhibits; talking, arm-waving dolls used in super markets to advertise commodities; and at least one object sold for home consumption, the Gilbert Microscope Lab. (This enables the user to look through a microscope at an object and hear a description of it. This system uses the peculiar technique of mounting the object to be examined in a slip-ring assembly at the center of a large-hole 45 rpm record. Thus the object is more or less stable while the narration goes round and round. (This shows a nice understanding of the salutary unified-loading principle.)

15.1 ANNUNCIATORS

15.2 MOBILE AUDIO

15.3 AUDIO/OBJECT KITS

15.4 AUDIO AND BOOKS, CARDS OR PICTURES

15.4.1 BOOK WITH MATCHING RECORDS

15.4.2. REKARD SYSTEM

15.4.3. BELL AND HOWELL TALKING CARD

16. AUDIO AND PROJECTION MIXES

Let me use the term "Mix" for any combination of audio and projection materials that have no "natural" mechanical linkage.

LINKABLE AUDIO-VISUALS

This heading includes practically anything that mixes the other techniques. Categorically speaking, this includes any combination of pictures, objects, or movies with audio. We will go through these one at a time.

There are no "natural" audio-visual packages, except perhaps those possessing a firm mechanical linkage such as the sound motion picture. Usually the connections of picture and audio are chosen by a system designer from among those technologically feasible. What predominates tends to be the simpler system, or one based upon a "natural" linkage of some sort.

To distinguish Mixes, let us adopt a simple alphabetical code: A means Audio, S means slides, M means Movies, V means Video. This AMV means a combination of audio, movies and video. (This notation can be extended with numbers: thus Mix SA 3M means eight audio channels and three effective screens. Let small "n" mean more than one.) ("Objects" are omitted from this notation, for obvious reasons.) (Numbers may be inserted according to the number of screens and audio.) Thus the Charles Evans film at the World's Fair: A 13 M.

At the present time a number of companies have selected proprietary systems which they regard to be of special goodness and robustness. These include, at the low end, methods of presenting individual pictures with some form of narration, and at the high end, multi-screen high-quality motion pictures with multi-speaker sound.

SYNCHRONIZERS AND PROGRAMMERS.

We might bear in mind that there are a number of ways of synchronizing dissimilar pieces of equipment. It may be done by keying one to the other, as by running a slide projector from a tape recorder. ~~This is usually done by keying one to the other, as by running a slide projector from~~ [illegible]

[illegible]

[illegible] a beep on the tape or a

[illegible] stick-on activating

an electric eye.) It can be done by human intervention. (For instance, as in the Walt Disney narrative records, having a character tell the reader to turn the page, or using some conventionalized acoustic symbol to remind him to do this.) It may be done by a common programming device or sequencer; this is usually called a programmer. (These devices come in all forms.) Or it can be done by a computer, which is far more versatile than any of these other systems, but far more expensive.

17 [illegible].0 REMOTE COMMUNICATIONS.

Great speculative stress has been placed upon the use of remote communications for teaching. I think some of this emphasis may be traced to the telephone company. People with primary responsibility for teaching ordinary classes are not going to communicate with them at long distances, except in an emergency or when section men really bear the brunt. Still, it is predicted by adherents of this approach that the "Great Man" somewhere will more willingly give of his time to lecture people by long distance than to actually come and greet his auditors face to face. Well, it may be that intellectual celebrities feel less put-upon addressing students from a cloistered setting, and so it may be a persuasive device; but in general the connections required will be expensive enough to require considerable scrutiny. It should be pointed out also that worthy causes (i.e.,education) pay the same telecommunication rates as industry; this has been the tradition;

and despite the recent attack from the Ford Foundation, this principle is likely to stand.

Naturally, these restrictions do not apply to instruction of inmates and shut-ins, where cost of receiving terminals is offset by circumstantial improvement.

17.1 REMOTE TYPEWRITER CONNECTIONS BETWEEN PEOPLE. One possibility is the use of remote typewriters, which allow people to talk to one another in ordinary words at what would amount to a very low expense in a large system.

I see this (in some form) as an important new form of communication, one with immediate corporate and personal applications as soon as it becomes practical; but for education, no. Typing is to many people an unfamiliar bother: they become embarrassed over spelling; they find it difficult to type and to compose at the same time. The rate of information exchange through typing is so low compared to that possible through speech that this seems to have no particular use for education, except perhaps for tutorial hookups when the tutor is

[This was made after copyediting, since unedited page apparently not copied before.]

a travelling man, and the help Of course, it might give well help the school's administrative system, but that's something else again.

C 17.2 ~~[illegible]~~ REMOTE HANDWRITING.

The use of remote-handwriting devices, common in railway stations and other industrial situations, is fairly inexpensive-- ~~it requires a~~ requiring only simple terminals and a 2-wire connection ~~and cheap terminals~~ but its use in education would seem to me forced and peculiar. For example, it might be practical though its value seems highly dubious, for students to ask questions of a remote lecturer by queueing up and writing these questions out, so that they appear one at a time on a scroll in front of the man who must answer them. Well, maybe.

Leave in 2-wire connection

C 17.3 ~~[illegible]~~ caps Facsimile. Facsimile transmission makes it possible to send and receive both written and pictorial information over low-grade transmission lines. This has been advocated talked up by various people--for one, instance, the Alden Company--as being one of the most powerful and versatile systems for all purposes. I would like to

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point out some of its restrictions.

For the transmission of written information facsimile is grossly inferior, in cost and speed, to computer transmission of the same information. However, computer transmission requires any text to be retyped for computer input. While it's okay for pictorial information, facsimile has only a two-day advantage over the postal service-- it works best on an overnight basis-- and it's far more expensive.

Furthermore, it is unattractive. The Alden-type systems employ gunpowder paper-- it resembles a fine grade sandpaper, which is splotchily blackened when a picture is laid on it on an electrical scan. It is coarse and unpleasant to handle, and I suspect that girls with long fingernails will dislike it even more than I do. On the other hand, the Xerox facsimile system, Magnafax, is inelegant too: it uses a stylus and carbon paper, and gives an image which is not very good. However, it has the advantage that it can use ordinary telephone lines.

17.4
~~16.3~~ LECTUREPHONE. Bell Telephone has been proposing to make lectures available over phone lines. This simply involves adding a loudspeaker at the receiving end.

Such a system is not very flexible. While obviously it may be good for shut-ins, or impromptu and emergency addresses, and various odd-and-ends applications-- it may be good for bigwigs who won't come and lecture but might speak free on a chatty basis-- but its incorporation in regularized curricula seems to me unlikely. It may well be cheaper to bring the lecturer to the students than to connect him to them electrically for an hour.

7.5 ~~16.5~~ REMOTE TELEVISON COMMUNICATION. Television can operate over great distances at proportionately great expense. High-resolution systems are obviously irrelevant here; but still TV and low-bandwidth scans need to be understood.

17.
~~16~~.5.1 Picturephone. "Picturephone" is Bell Systems' televison offering, and it is being ballyhooed for

educational uses. Currently it is in operation between New York, Washington and Chicago.

The economics of Picturephone are atrocious. A picture requires more bandwidth than voice; effectively Picturephone employs something like two dozen telephone lines electrically bundled together, and because of the constraints mathematically established by information theory,it always will. Thus it will always cost at least as much as two dozen telephone calls, in addition to the price of the transmitting and receiving equipment.

17. ~~5~~.5.2 Pseudo-random scan systems.

Work has been progressing on video systems which employ, not a standard rectilinear scan, but a scan which plots a distributed pattern of points with no particular shape ("pseudo-random"). Such systems produce a pleasing moving image through a channel with less bandwidth than had been thought permissible. However, these systems are still in the research stages, and they would not likely lower the bandwidth requirements of video by less than half.

~~15~~17.5.3 Slow-scan video to storage tubes.

For use by individual students, one of the most promising possibilities in televison systems is the slow-scan system employing storage tubes. Most people do not consider this acceptable for communication, since it delivers only a succession of snapshots of the person you are conversing with, and this is felt to be inadequate to evaluate his expressions and movements. Slow-scan storage-tube video would, however, permit students to obtain new screenfuls from a central control device; words and pictures could be made to appear on the screen, and branching possibilities explored according to the choices of the individual student. Halftone would be easy, and photographs, as well as grey-scale art work, could be freely employed. In other respects it is just like computer display, and consequently something which must be weighed in direct comparision to individual-student computer display.

It is obviously one of the rival systems which must be considered. While systems of this type can have the grey scale that computer displays currently lack, they currently lack the definition now available in computer display.

For instance, an ITT system costs only $5000 or less ~~a~~ per receiver, and will work over telephone-grade lines. This price may well drop considerably.

18.0 TELEVISION. "Television" means any method of producing a picture by varying the brightness of an analog signal swept repeatedly over an area in a scanning raster. The raster does not have to be rectangular (it could be a spiral), and its speed and sharpness of definition depend on the engineering features of the system. Normal television (that is, normal in the United States-- we standardized early on an inferior system)-- has a framing rate of thirty frames per second and 525 scan lines. Television in Europe-- I believe that the British and Continental systems are incompatible with each other and with us-- has higher resolution.

Terminology is extremely loose, but if we call home television "normal" we usually call sharper television "high resolution" and less sharp television-- that is, television with a slower framing rate and less definition-- "slow-scan." Normal TV demands a high bandwidth, high resolution TV demands a very high bandwidth, and slow-scan TV can have a very low bandwidth-- indeed, one of the systems mentioned below carries adequately over ordinary 3kc telephone lines.

Television is universally known and "understood." Children cry for it. People learn things from it. Therefore it seems attractive to many school people. In discussing the disadvantages of educational TV, let me completely ignore cost factors, since obviously these will change.

18.1 Broadcast, network & large-scale scheduled TV.

Many people think that network educational TV is a vast solution to various problems of education. It has a number of advantages. One is that the viewer feels that he is closer to the speaker than a large lecture hall would permit. Another is that thousands of persons can be exposed to the same lecture simultaneously; the overall costs of a special presentation may be averaged over a much larger number than those that may be assembled in a single classroom. Another advantage is that the same materials may be sent to remote locations; indeed, many schools at once. A video setup can respond swiftly to current events, with lectures on the latest happenings in outer space or world eventsshortly after they have occurred, reaching thousands of students in a very short time.

The complexities and troubles of network TV are much greater than may be immediately supposed, though, and these need to be understood, for they may swamp the advantages that appear at first. The number of video channels in any system will be finite, and probably small. There are likely to be only two, four, or possibly a dozen separate channels available in a system. To put something on any one of these channels will tie up either a studio or a tape machine; thus complex scheduling of all facilities is required for the broadcaster: thus the schools cannot treat lightly the use of any of these facilities and great steps must be taken to keep them occupied profitably.

18.11 Spot use of TV in ordinary classes.

18.12 Specials; agglomerating students into big viewing groups.

One of the most profound difficulties with educational TV is the problem of scheduling. All students must be collected at viewing points at the time that the program comes barreling through. For a one-shot show, on a single occasion, they only need to be gotten there once; if it is a series of programs, they must be brought to this point again and again and again. It should be evident that the formidable scheduling problems which schools already face today may be considerably worsened by this. If great throngs of students are gathered into great auditoria to watch the show, the problem of discipline and order can be explosively greater, and numbers of student monitors and faculty personnel must be tied up simply in the process of moving people in and out and making sure that nothing untoward happens during the viewing session. Not only will this introduce an autocratic atmosphere, but it will tie up teaching power in custodial activity. Where a number of schools tie into a common TV network, the problem is exacerbated: differences in curriculum must be overlooked in getting everybody to the viewing point. The probable result is that very large aggregations of students are going to be sat down to watch not-very-appropriate materials, and it is likely that the circumstances of viewing may well not be any improvement over the ordinary one-teacher system.

To sum up big-system TV: it will probably tend to be inappropriate and inconvenient. Extremely artful or vivid materials, or highly skilled and interesting teachers, might reduce these disadvantages somewhat.

18.13 Slow-scan and low-bandwidth video transmission. These topics ~~will be~~ are covered under "Remote Communications" (   ).

18.2 Video recording in general.

Video recording must be understood to be relatively recent; it was introduced only in the 1950's, and became widespread only by the end of that decade.

Video recording can (almost axiomatically) never "equal" the quality of the original television, but for practical purposes most receivers and monitors are not good enough to show the difference between recorded and "live" TV. (This is very different from the problem of comparing high fidelity with natural sound. We do not compare the video recording with the original itself-- the true object as it appears to the naked eye-- but we compare it rather with the live broadcast, which next to normal sight is a sorry thing indeed. Deterioration of the image between the live broadcast and the recording is much less than making video of the object in the first place.)

Videotape was at first almost impossible to edit, since it was divided into invisible sectors. Recent techniques ('development' and viewers for tape contents) have changed this, but it is still a great bother. A fair rate in cutting plain audio tape is five minutes per splice; fifteen or more minutes per videotape splice seems probable. This may mean, in practical terms, that videotape cannot be as well edited as movies.

Problems of editing on (and for) video discs have not been explored yet.

Video recording vs. film. Prior to video recording there was the kinescope, a movie made straight from the television screen. While this looks terrible, particularly if retelevised, the kinescope is still a much less expensive method of permanent recording than videotape.

Crossover point. A critical matter is the cost/quality tradeoff between films and videotape. In the past, and still at the present, final prints of 16mm sound films are cheaper than videotapes lasting the same length of time. There may come a time when videotape will probably not go down quickly; the production techniques involved are not due for any clifflike reductions, as are the techniques used to produce electronic circuitry. We may expect, say, a reduction in tape costs of one half in the next five years and perhaps half again in the five years after. This should contrast with the reduction of two-thirds or three-quarters in the price of computers, audio and video equipment during each of these two five year periods to come. I find it quite likely, then, that for the next decade the cost of magnetic video recording will be equal to that of motion pictures, on a per-minute basis.

The cost of videotape recording, and of selling prerecorded materials in this medium, will be at best equal to the cost of movies. Of course, production costs might be lower simply because in the videotape medium people may accept a lower quality level because that's the way television ordinarily looks. Since the quality of the motion picture image is much greater than that of the video there must be pressing reasons to accept the video instead. During the few years to come I cannot see why anyone would prefer the video. It is hard to justify prerecorded videotape unless the materials could not be obtained on motion picture film, or originate[illegible] on video; e.g., scenes that require leaving the camera on for hours to capture unpredictable phenomena. But, of course, this video image may be put on film without image degradation (except that of transposition and size, which make it look "psychologically" worse). The most sensible use of the video recording medium, then, is where the videotape could be erased and reused for another purpose. If the material is to be kept, it is cheaper to keep it in motion-picture form, assuming that this is otherwise feasible.

18.21 Videotape.

I believe that the original videotape was two inches in width; now the standard recording devices have come down in width to one inch. While the quarter-inch Telcan system for $250, announced in 1963, never materialized, half-inch systems are now available from Sony, Ampex and Shibaden. These appear to be of acceptable quality. Whether they are compatible I do not know.

18.22 Video recording performed in schools

For various purposes, the use of video camera-recorder chains in schools may prove to be a powerful educational technique. For example, teaching public speaking, proper diction, "How to give a Book Report," and for allowing students to see their own Science Fair presentations as others see them, this will be an invaluable and unprecedented tool. (There is, of course, the disadvantage that many people become extremely upset when they see themselves, finding the apparition quite offensive to their own previous self-image.

This effect is often observed with audio recordings, and may turn out to be worse with video.)

For recording lectures, as well as such extracurricular events as playlets and school ceremonies, the video recorder should be fascinating.

In these respects it will be a sort of toy, or, to be more charitable, an acurricular real-life-experience adjunct, like the rolling stock used in Driver's Education courses. Its educational effect will be separate from those grand trains of presentation embalmed in the formal curricula.

18.3 Video disk.

18.31 Magnetic video disk recording.

18.31.1 Moving video on magnetic disk.

The MVR Videodisk holds twenty seconds (600 frames) of real-time video on a twelve-inch metal disk. It also weighs only 25 to 50 pounds.

Uses would center around 'critical moments,' to be reviewed.

18.31.2 Single frame video on magnetic disk.

18.31.21 Single readout.

The Data DISC, Inc. Model M Video Disc Recorder stores 131 standard video frames on each side of a metal disk cartridge, but permits only one to be read out at a time. Presumably each image may be held as long as wanted.

18.31.22 Independent readout. Model F holds only twenty frames, which can be read out independently to different monitors at the same time.

Uses of the model F should be principally restricted to bulletins and announcements. Twenty images is not many. To change them presumably you must change disks or switch recorders.

18.32 B. Mechanical video disk recording.

18.24. 1 Westinghouse Phonovid system.

Westinghouse has announced a slow-scan storage-tube video system, Phonovid, which stores TV images on a vinyl phonograph record. Because the bandwidth of the phonograph record, though respectable, is by no means that required for real-time television presentation, the Phonovid system can only present stills. In this respect it is about equivalent to audio filmstrips; the makers claim that they can fit 200 still pictures and 40 minutes of sound onto one disk. This promises to be a hundred times less expensive than computer-type erasable disk systems; duplicates can be made through the ordinary phonographic process at the same cost as an LP record, which is perhaps a dime. This low cost is an incomparable advantage. In other words, if the machines were sufficiently widespread to provide a market, materials for them could be made with a handsome profit and still sold at low cost.

The properties of this system

depend on details not yet public. If the new picture begins automatically a certain time after the completion of the old, it will hold materials to rigid timing. If a special sync signal begins a new frame, which is more likely, a given picture could remain as long as desired; moreover, partial pictures-- at the top, bottom or side, depending on the scan-- could be included in the narrative sequence. Such possibilities would require detailed examination.

18.25. Single-frame use of addressable videotape.

At least one company (Sony) sells a video tape recorder for under ten thousand dollars, the PB-120U, that can be used for stop-action showing of single frames under remote control. ~~However,~~ Ampex makes a similar unit, the EV-200. it is not clear that such things can be easily found on the tape, or that a workable indexing scheme can be established, or useful search hardware added, to find specific frames automatically. It remains to be seen whether this can be an adequate presenter either of single images or short lengths of motion photography.

Under the latter assumption, Choster Electronics in Connecticut has built remote-control tape-searching apparatuses with both the Sony and Ampex units, presumably for dial-access TV systems.

18.4 Addressable videotape/disk system: Ampex Videofile.

18.27. The Ampex videofile

The only truly addressable TV unit now on the market today is the Ampex videofile. The videofile consists of a video monitor attached to a large diskfile; the diskfile receives materials from various addressable videotape recorders which are attached to it. The user may request a specific "document" (frame), which is then sought on the reels of tape, transferred to the disc, and presented continuously on the screen.

This system costs hundreds of thousands of dollars, and is of interest here only because its overall makeup may presage a less expensive video-image filing system of the future.

18.5 Student use of video recorders.

A perfectly straightforward use of video in schools, and I believe a very promising one, is the use of video recorders by students to study prerecorded materials, created either within the school system or outside. This may, of course, have to wait until video recorders of very low price can be placed around the schools and made directly accessible to the student for personal use.

18.6 Dial-access TV systems.

There are two ways to run a dial-access video system.

18.61 Common Programs.

One is to give out specific programs at specific times, and give each student the option of selecting one of these in his carrel. If so, it is not clear why carrels should be used instead of ~~separate~~ group viewing areas grouped around separate television screens.

18.62 Unique programs.

The alternative is to assign each student his own video tape machine, out of reach, but connected to his TV monitor, and allow him to direct what material he is to receive on that monitor. In this case, it is unclear why a dial-access system should be used when we could simply give the student his own video tape recorder and allow him to put material on it that he wished to see.

Why dial-access? The sense of prestigious participation, of dernier cri, is important, but rarely justifiable if it costs more than a dollar a year. A better reason for the dial-access system is to prevent mischief or accidental damage. Tapes are easily harmed or destroyed; though mischievous insertions are less likely with video than audio, in which so many young people are competent. Another, and perhaps better reason for dial-access is the comparative ease of administration. Materials are handled only by employees or trustees; it is possible to avoid all the inconveniences of the interface with users, such as the desk, desk staffing, record keeping, materials checking, coercion and penalties.

18.7 Prerecorded video as object of sale.

Prerecorded tapes could be used on network systems, individual recorders, or dial-access systems, as explained above. Another point about prerecorded TV tapes: they could accompany a live teacher, being either intercut with scenes of the live teacher (in school network system), or overlaid on the picture of him (as with prefabricated diagram animations), or perhaps it could be used by the classroom teacher as an adjunct with "explainable" or "explanatory" films. It would then be like the film loop or overhead-projector foil; good demonstrations could be worked into any course.

19.0 SHOWS

Why merely package motion pictures or videotapes? Why not include other parts of the presentation in the marketable package, including, if desirable, live human individuals as actors, narrators and so on?

This is widely done in our industrial musicals. These play to both the laity and to members of corporations. If they appeal to adults, they should appeal the more to students, if they are not dreadfully hokey and false.

19.1 Big stage shows.

Such big stage shows as the General Motors Futurama, which has been and may still be a travelling annual (at least that's what it was before the pavilion by that name at the World's Fair), have shown the value and absorbing capacity of well-mounted stage shows. This is mentioned merely as a logical possibility, and not because it is likely to be justifiable in a conventional educational context.

19.2 Travelling shows to the classroom.

On the other hand, why not package travelling lectures with complete audio-visual presentations? I mean: create a package having one, preferably two, lecturers, fully in command of a specific range of material, their own equipment, and the showmanship and human dealings of handling classes. Give them a complement of reliable equipment and a large quantity of slides, prerecorded audio, and motion picture short strips. Hammer the whole thing into a forty-five-minute or half-hour presentation with plenty of punch, and prepare them for fielding questions with further presentation material. Set them up also to leave something behind, such as a pamphlet for each student, with lasting interest and mnemonic value.

Presumably this would tie in with any textbooks; it would leave the students invigorated by the experience, and provide for all sorts of other tie-in with our own materials. (There could be lots of additional things to print.)

This general technique can be compared to selling vacuum cleaners: having a large armory of equipment and presentation material all ready, and laying it out in a dramatic and interesting way under a smooth, prepared script, carrying the viewer along as a participant. In the vacuum cleaner sales pitch this can be virtually breathtaking. Why not apply the same interpersonal and presentational techniques for the Lord's work?

There are obvious similarities to the commercial show; the World's Fair presentation; the magic act; the vaudeville turn; the narrated travelogue; and the Huntley-Brinkley show. These all use classical techniques of showmanship and personal interaction.

This would have the great advantage over ordinary lectures of being properly rehearsed. It would be fail-safe: if parts went wrong-- say, a specific projector-- the lecturers would have the presence of mind and the preparation and the experience to fill in so completely that its absence was not noted.

Such antics would increase everyone's interest in the subject, and perhaps awaken and refresh the background and refractory students, giving them some sense of what the field is like in a way that permits them to slacken their resentments and commitment to non-interest.

From the point of view of the teacher, this would offer a number of advantages over audio-visual materials that he must handle himself: he himself need not fuss with the machines, or run the risk of embarassment; he can maintain a teacherly relation to the class and stay in charge; the class will stay orderly; the machines will not fail-- they will be clean and well run, with crisp sound, clean gates and so on; and the live persons from elsewhere will awaken new interest. The show will derive added oomph from being shown on machines with which the kids are unfamiliar.

Indeed, sociologically this technique would build up the teacher in the eyes of the students at the same time it required him to do nothing. The presenters could confer with him in advance and include him at various points, either by reference or in the dialogue. Individual students, too, could be incorporated in the presentation in an engrossing way, as "hold this" stooges (an opportunity for comedy), rehearsed shills, or foils for prepared dialogue. (However, it is probably important to let the presenters use their own judgment, rather than accepting the teacher's word as to which particular students are "good" and which "bad.")

Unfortunately the economics of such a show may be discouraging. Presumably such a show would be cheaper to produce than a movie of comparable length (about equivalent to preparing sound filmstrips of that length) with some motion picture material added. Could a school afford to pay the one-time charges necessary to make a profit on such presentations? It is by no means sure that they could. The probable cost per showing might be a hundred dollars or more, and it is not likely that schools could scare up that kind of money even for aggregations of several classes, let alone for the single classes in which it would be much more effective.

19.3 Roll-in presentations.

A lesser but viable version of the show above would involve a roll-in projection and audio device (plus screens), under the supervision of a single attendant who had no speaking part. The teacher would have the job of introduction and windup. This would have some of the advantages of the traveling presentation, but lack the impact of personal contact or the showmanship and teachmanship that can be brought to bear by a live person working in a real situation. However, it would have the advantage that the teacher need not concern himself with running the equipment, and can maintain order within the teacherly framework which he likes. In other words, providing roll-in a-v materials all set up to show might well be an interesting thing to look into.

20.0 ARCHITECTURAL AND MOBILE SYSTEMS.

The topic of architectural and mobile systems is large; the systems, indeed, can be very large, and can include any of the other audio-visual or printed media.

These systems are concerned more with the delivery of material than with their content. They possess certain rather extraordinary advantages, and peculiar disadvantages of their own.

I would say that the topic of "architectural" media included things as large as Central Park or Freedomland; expositions; pavilions (tents, domes or other buildings at a larger fair); museums (which are stodgier); and things that can be built or dragged into ordinary school buildings, such as little exhibits or study carrels.

20.1 Fairs and Museums.

The distinction between a fair and a museum is apparently that a fair is spread out on a large ground, while a museum is in a single building; or, a fair is the work of many different groups, the museum is a single administration. Where to put Disneyland in this dichotomy is uncertain. I see no purpose in distinguishing between the two; let's say that some ("fairs") can be more spread out than others ("museums").

It is the trouble with a museum that the museum official is generally confronted with the problem of housing and displaying materials that are possessed, rather than accepting th challenge of showing things that should be shown, which is more like what the magazine editor does. As I recall, there is a passage in The Catcher in the Rye which says this well, describing the way New York's Museum of Natural History seems to a child: unfathomable and peculiar, and enticing more for its atmosphere than for the interest of the things which may be seen there. (However, I have not checked the passage.)

Contrast with this the fact that parks run for educational entertainment are fun: for example, the Museums of Science and Industry in Chicago and Boston.

Consider Freedomland. It started with a rather interesting idea: a map of the United States with "typical" or "appropriate" exhibits and pavilions in spots corresponding to various geographic areas of the United States. (This may have been an outgrowth of a much earlier idea, to hew Central Park in the shape of the U.S.A. for educational purposes.) I would submit that with different motivations of the proprietor, such a thing as Freedomland could be a very educational and exciting place to be. For instance, consider a "park of knowledge"-- an aggressive museum built around ideas and subjects rather than on objects requiring preservation. Such a park could offer effects not striven for at most museums, while at the same time being pressed by cost-accounting and efficiency considerations into a striving for simplicity, drama, ease of maintenance, compactness and various other desiderata. If this were near a city, it could run bus services to and from the schools. Its changing exhibits and shows could be phased to the academic calendar (Ancient Lands in the fall, Declaration of Independence in March, among others). Rather than passively trying to cope with school tours it could build most of its features *around* school tours.

It would be among ~~Among~~ its interesting advantages that this could simplify the policing problem for teachers in attendance. Runaways or strays would find that the only accessible adjacent rooms were *also* germane to the subjects being promulgated.

One problem with such a Park of Knowledge would be the considerable difficulty of starting small. An initial offering would require developed action exhibits in several areas. However, it could begin out of a traveling-show effort in which many completed offerings were available. It should be noted that anyone who opened a park of knowledge, or museum with equivalent purpose, and took it upon himself to build modular exhibits for it, could also move these around the country. Thus creating a fixed exhibition would also entail creating a traveling-show set up of some kind. The exhibits, if cleverly constructed, could be collapsed to a standard size for storage or transportation-- for example the size of a Sea/Land trailer-- and made nationally or internationally mobile.

A last point about fairs and museums. I think that motion through them, as well as any manipulations performed by the viewer on his way, gives the materials a special vividness. Perhaps this is like imprinting ducklings by making them walk behind a duck-figure. Perhaps this is why the peripatetic scholars were so influential.

20.3 Special purpose prefab exhibits; mobile ~~positions~~ pavilions.

It might well be worthwhile to prefabricate exhibits for special purposes and set them up where wanted in any part ot the country. Whether these should be collapsible, for later transportation elsewhere, or simply erected on the spot and destroyed when no longer wanted-- "throwaway rooms"-- would depend on various things. When talking about periods longer than a few days, throwaway architecture may be less expensive than mobile setups. The architecture of cheap temporary structures--

where permitted by codes and unions--has gotten very efficient; cheap and modular packaging, too, has made the creation of traveling anything easier and more powerful.

These could be "exhibits," i.e., relics and three-dimensional statuary, as in ordinary museums, or, preferably, prepared shows in various types of Media Mix, supplemented perhaps with relics and statuary, and pamphlets and other giveaways.

At least two possible bases for such productions are possible. One would be a standard traveling show; however, the propects for materials on any sort of intellectual plane are not encouraging here (Cf. The Circus of Dr. Lao). Another would be the circulation or construction of exhibits for schools and institutions, either on a subscription basis or a' la carte from a catalogue. Perhaps the school systems of small cities would be the best customers: big enough to use the setup, small enough to keep changing it.

20.4 Displays that could go in classrooms.

About bulletin-board and glass-case exhibits I have nothing to say here. The most effective displays are those one can walk around, those which have a spatial "feel", those which use color and light and motion in interesting and effective ways. It would be possible to make such things in a form that can be rolled into a classroom for a few days' use.

20.5 Carrels and in-class roomettes.

Packaged materials may often require their own surroundings. This is probably the case with materials to be read in carrels; besides supplying matter and hardware for self-teaching, the publisher may well have to supply the carrels as well. Thought should be given to ways of putting fold-down carrels onto the walls, or hanging drop-down carrels from the ceiling. It may well be that new methods of compacting carrels together in knitted structures, thus packing them more densely, would contribute indirectly to the sale of materials for use in them. Perhaps study carrels of an irregular shape which could be plugged into and onto one another to make large-scale outdoor or indoor structures would be of interest. Perhaps by departing architecturally from the rectangular-box idea of rooms, and switching to something like bleacher construction (with vibration eliminated), dense and effective carrel packaging could be accomplished that much more effectively utilizing the available architectural space.

20.6 Self-Mobile systems.

20.6.1 Mobile shows with live participants.

Most of the good features of traveling man-machine lecture presentations would persist if they were packaged in buses or vans; so would most of the bad. However: showmen would probably not have the opportunity to confer with particular teachers about plans and coordination. On the other hand, equipment and plugs would not have to go in and out of doors and sockets, and the setup could be much more tightly scheduled: seven shows a day as opposed to three. Variations on the same material could be presented at different levels at the same school on the same day. Selling cost might be proportionately lowered.

20.6.2 Mobile 'Media Mix' presentations (no live participants).

The good features of 'Media Mix' presentations would persist if they were packaged in buses or vans. Indeed, this might be the most sensible way to do it, since power, cords, screens, focus and acoustics would all be known and controllable.

20.6.3 Mobile Computer Teaching Setups.

Fitted buses and trailers, with carrels, perhaps computers and other equipment, may well be one solution to the question of how to package computer displays (q.v.) for school use. Classroom space is short anyway; why not add to it, rather than occupying it, by driving the system up to the door? Moreover, this would allay some of the feelings about high cost associated with the present use of computer-assisted instruction, especially if these systems were made available for short periods of time, which would only be practical on a mobile basis.

Moreover, the machine could be driven away after school hours and perhaps used elsewhere.

21.0 COMPOUND TEACHING MACHINES.

As "compound teaching machines" I would embrace all devices which incorporate other than printed materials, and respond to particular user choices.

It is not likely that illustrations presented as color slides are going to be any better than those which can be printed in black-and-white (except where it is needed for the subject, such as anatomy or art history). Nor is it likely that audio contributes particularly, except to poor readers and the undermotivated. (There may also be special cases, such as operating on electronic assemblies under dictation.)

These machines possess a hidden advantage, however. This is their value and unavailability. A programmed text in a book, something that can be picked up and put down, is likely to become an object of disaffection, disrespect and procrastination. A machine which is expensive and on loan for a limited time-- or even tightly scheduled-- exerts pressure on the man to use it; it's a resource which must be exploited on schedule.

21.1 MIX AS, ASM UNDER CONTROL BOX.

AS and ASM mixes, stirred into a teaching program, may be handled through a control box like those described in section 13. No such system is now available, however.

21.2 HUGHES VIDEO/SONICS.

A system that is being pushed, and has certain good traits, is the Hughes Video/Sonics system. This uses a centerfeed/loop tape cartridge (having the advantages of tape for editability) and a slide cartridge. The user may make various choices at the faces of the machine, and corrective procedures-- presumably of the bridging type-- become available.

This system is available in a number of models.

21.3 IBM 1500 SYSTEM.

An AS mix is available under the IBM 1500 system, combining the 1512 Image Projector and the 1505 Audio Adapter, both of which are controlled by the central computer under the 1500 Operating System. The 1512 Image Projector can address and select from among 1000 single-frame images stored on conventional 16mm sprocketed movie film. However, these components are not expected to be used except with the 1510 CRT console. This system is further discussed under 24, Computer-Assisted Instruction.

22.0 MISCELLANEOUS COMPUTER SERVICES (of possible use within an educational context).

There are many possible computer applications which have been deemed to have educational value, though they are not (except for the BBN effort, below, yet being offered for use within a school setting.

22.1 CALCULATOR; CALCULATOR DISPLAY

The use of large computers as remote calculators, while seemingly peculiar, has a number of significant applicators. A negative aspect is the high cost of data communications, but we will put that aside.

22.1.1 Keyboard calculator.

Not only can a keyboard calculator hooked to a big computer perform the standard arithmetic functions, but it can also (through programming) automatically perform mathematical evaluations-- such as log, cosine, and cube root-- which cannot be wired into a small unit. These functions may be added to the calculator keyboard. In addition, the pushbuttons may be linked to pre-stored programs that have been written by the user (assuming that they will be accepted by the computer installation). This approach assumes single numerical answers to discrete questions.

Control Data makes a unit for this purpose and sells the calculator service on a rental basis.

22.1.2. ON-LINE NUMERICAL PROGRAMS

A more general approach to teaching through the numerical use of big computers has grown out of large-scale on-line time-sharing systems. Various numerical services available to users of these systems are said to be salubrious for educational purposes.

Dedicated Systems. Various big systems, such as JOSS, OPS at MAC and AMTRAN are exclusively dedicated to numerical services. The use of such service by students may prove an important educational technique.

JOSS. The RAND Corporation, originally on its home-brew designed-by-~~van-Neuman~~von-Neumann-himself JOHNNIAC, and more recently on a big PDP-6, has offered its members a service called JOSS. (This stands for JOHNNIAC

On-line (Something) System, and the name has survived the original computer.)

The JOSS system provides users with simple numerical functions, available in an instantaneous dialogue, and the storage of numerical programs written in a short declarative format. It takes only half an hour to learn, perhaps an hour to learn well.

(Applied Data Research has recently implemented a version of JOSS for the PDP-8.)

BBN. An outgrowth of JOSS is being used experimentally for education by Bolt, Ber~~sick~~anek and Newman. It runs on the PDP-1. It is being made available by teletype to school children in the Boston area. Bolt tells me that this system has dramatic effects in student motivation and grasp. One student in particular, never a math student, in his first hour with the system discovered an important theorem in the theory of numbers for himself. (Note that this is on a teletype system.)

BBN has also been working with Culler on the development of the Teleputer and its programs, though what relation this bears to the system is not clear to me. The Teleputer does offer a second keyboard above its typewriter keyboard, with special mathematical functions laid out.

General-Purpose Time-Sharing Systems

Great systems have been, and are being constructed for the use of big computers by many users at the same time; these systems even provide protective features so that users may debug their programs on-line with the computer without clobbering the system. While proprietary time-sharing systems are available-- the PDP-6, the SDS 945 (time-sharing system developed at Berkeley), and the SDS Sigma 5--the king of the systems has been Project MAC, at MIT.

7094 CTSS. The first version of MAC, the CTSS system on the IBM 7094, has been operational for several years; it accommodates about thirty users at a time, although some 200 dedicated terminals exist.

At one time a MAC terminal was available in the basement of Cabot Hall at Radcliffe College, for use by the Cliffies. I do not know what it was used for or how useful it was.

645 MULTICS. The coming version of MAC, called MULTICS, is being developed for the General Electric 645 computer, though programs for it are being created on CTSS, which is currently shut down to other uses. Supposedly MULTICS may accommodate two hundred general users at once, but this simply remains to be seen. Whether it will simply be available for hire to anyone who ~~puts~~ rents a 645 system (for millions of dollars a year) I do not know.

22.2 SIMULATION.

Computers can, when suitably programmed, simulate situations and environments of virtually any complexity, and demonstrate what changes will come about in them over time through intrinsic or random causes. (However, the simulations may take longer than the real events, so there are potential problems.) In recent years, such general-purpose simulation languages as DYNAMO, SIMSCRIPT, GPSS and MILITRAN have passed from development into general usage, but their use is still restricted to computer programmers.

However, it may be anticipated that simulation programs will soon be packaged with special front ends for consumers (much as an analog computer plugged up for a specific equation is now being marketed as a "stock market computer"), and users of terminals will be able to get immediate simulation of grain futures, traffic flow or thermonuclear war. It should be noted, of course, that the difficulty is not merely in the programming, but the lack of well-formulated models in most fields which are both appropriate for simulation and agreeable to the theoretical content of the field.

In any case, packaged simulation facilities may turn out to be an important educational tool; where is hard to say. Population growth and decay simulators might be of equal use in biology and social studies. An input-output flow simulator would be of use in economics.

22.3 COMPUTER GAMING.

Computers can be included as either active or passive partners in gaming, whose educational uses were mentioned earlier. Computer-supported gaming can have educational as well as ~~exploratory value,~~ research value, though in recent years it has been exploited chiefly for research. There is an interesting question as to what this activity should be called. Properly, it should be called gaming. (However, because of the frivolous connotations of this term, the term "simulation" is coming into use. Gratuitously;

but the circumstances of sale may preclude calling it by its right name.)

The computer can be either passive or active partner in gaming. As passive member of the game, the computer can store the entire board, that is, keep track of the various situations, progressions of the players (and their "pieces" if any), and, in particular, it can keep track of advancing situations of a complexity that would be impossible with an ordinary board game. Ordinary board games are limited by the difficulty of simulating truly massive or mathematically complex situations and developments. Through the computer's manipulation of the abstract circumstances in the game, situations approaching any desired complexity may be generated, maintained and displayed; making them seem complex is of course much easier.

22.3.1 Group play with computer as passive partner (environment).

The computer can be made to

simulate the weather, God, public opinion, Community Chest, and any other pushy factors or environmental activities that are supposed to be random, unpredictable or complicated.

The business simulation game at the University of Chicago is of this kind.

22.3.2 Group play with computer as active power.

The computer may be given the role of an active player in the game,
and (satisfactory to all
and (except with exceptionally sophisticated players who will try to dope out its true principles of operation), firmly and consistently play the game a certain way.

Note that this requires a level of operational complexity in the game somewhat less than chess (computers can't play chess).

It may be important to conceal the fact that one player is a computer, particularly with sophisticated users who will try to dope out its principles of operation. But in many cases this will not matter, for instance where the computer is made to act like a relentlessly agressive foreign power (see next entry).

22.3.3 Team gaming with computer as common adversary.

Especially in games where the object is to teach cooperative organization, the computer may provide the general obstruction to be counteracted.

22.3.4 Solitary play with/against computer.

In this perhaps limiting case, the computer is both active and passive partner (environment), mimicking both an intelligent decision maker and the background on which actions take place within the game framework. This could be an inexpensive way for the student to practice important decisions and procedures.

22.4 COMPUTER INFORMATION RETRIEVAL.

The term "information retrieval" is one of those glamorous pseudo-technical terms fraught with apparent importance and redolent with space-age allure. In fact information retrieval can mean any number of things, many of which are not complicated and many of which are not important.

Within the technical disciplines, especially the "new field" of "documentation," "information retrieval" has taken on two discrete meanings. The first of these is document retrieval, the second the question-answering system. Other senses of "information retrieval" will be discussed after these two.

22.4.1 Document retrieval

A document retrieval system is any system-- such as the card file in a library-- which is employed for the accessing or addressing of existing documents. The library card file, printed book index, bibliography and so on are perfectly straigntforward document retrieval systems whose drawbacks are understood. On the other hand, "advanced" document retrieval systems have gone in a number of directions to index documents for more powerful accessibility.

The first of these advanced document retrieval systems is called *coordinate indexing*. Documents are indexed by their different areas of relevancy, whose combinations may then be requested by the user. It is called "coordinate" indexing because its descriptions may be called for *together* like the x and y positions of a point on a cartesian graph. The most esteemed indexing scheme today is the relational indexing approach of Thyllis Williams, a librarian. Her system involves coding the contents of a document according to its topics but also by the relations of topics one to the other. In other words, this system adds relational coding, and a whole new set of difficulties, to the various potentialities of simple indexing. On a theoretical basis this can be justified to some extent.

Typical document retrieval systems require the user to learn some symbolic-logic-like notation for requesting compound things of the system. For example,

32 V 22 V 16 . 12

This would ask a system for any documents coded under topic 32, or topic 22, or topic 16 and topic 12, but neither of these separately. (Note that typically the system has either too many documents answering specification requested, or too few. Thus the user must 'negotiate' with the system, widening or narrowing his request until he is satisfied with the results, if ever.)

Formalized document-retrieval systems are in use in medical libraries, scientific and technical fields, and presumably in our defense and intelligence efforts. But it will be a long time before we can tell what good these systems are, and for what purpose. New generations of sophisticated users must know enough to explore the possibilities of these systems well, and critize them adequately from this understanding.

One trouble with all of these systems is that coding is extraordinarily expensive: customarily only college graduates are hired for this, and despite sweat shop conditions, quality control raises the cost to an inordinate price per indexed document, often several dollars. Even at premium rates the reliability of these systems is apparently low. And their usefulness, while probably [illegible] greater than that of previous library indexing systems, has not been demonstrated to be extraordinarily greater.

22.4.2 Content retrieval, or QAS.

Another meaning of information retrieval is what we may call content retrieval (often called fact retrieval or data retrieval). I personally prefer the term QAS, or Question-Answering System. The QAS is any overall scheme for containing items or webs or knowledge and answering users' questions out of this knowledge bank. One of the most famous early systems of this type was the so-called "Baseball" System, which could accept and answer reasonable questions in English about various historical baseball facts. Such systems are complex, not yet being "solved" in the general case; their exact range of usefulness and practicality is not yet clear. I find them most admirable but they are also most expensive. The Baseball System can answer the question, "Who won the World Series in 1932?" The most heralded content-retrieval program, that of Fisher Black, can, if told "I am sitting at my desk, my car is in the garage-- how can I get to the airport?" can answer it. This is regarded as having solved a problem in principle. Notations, storage systems and analytic schemes for these purposes are still under development.

In general the success of systems may hang on the development of exact procedures for analyzing the English language. If we can learn to break up the English language according to a rule-like set of procedures, then the questions can be "understood" by the machine with relative simplicity, and answered accordingly. Failing this way of pressure-cooking normal English into digestible fragments, an interesting alternative has been Lee McMahon's creation of a new English dialect, FASE. All sentences in FASE are perfectly good English, but all good English is not acceptable to FASE. McMahon has concurrently developed, of course, a set of procedures for exactly breaking FASE into its components.

22.4.3 File accessing.

Among persons concernined with the programming of actual computers, the term "information retrieval" means something much more straightforward: any particular way of getting information out of a storage device, particularly those employing non-trivial coding methods or pointer schemes. Thus "file accessing" is a synonym for this sense, and "file search" and "list processing" are closely related terms.

22.4.7 Quick-look devices.

A last sense of "information retrieval," and perhaps that most germane to the proposal of systems for secondary schools, is what I would prefer to call the "quick-look device." By a "quick-look device," I mean any system, picture or accessible thing which will in some wise help the student remind himself of something he wants to know, when he wants it (and is permitted to look). I would include under this title such simple things as the large letters which are posted around a kindergarten so that children can learn to write; a human skeleton in the corner; the periodic table of elements; a map; a table of dates; an exam pony. Materials printed on the inside of book covers are usually of this kind. The incorporation of quick-look devices in computer systems-- especially, of course, computer based display systems-- is a matter of aesthetics, economics and pedagogy. But obviously you don't need a computer for a quick-look device; illustrations, charts and tables, allegorical illustrations and mnemonic schematics can all be made separate or bound into books.

22.5 Media Mix Controller.

A full-scale computer is the most flexible device for the control of a combination of audio-visual devices. Indeed, it may be cheaper to perform remote hookups for on-and-off control than to install the standard teletype.

No such arrangement exists, to my knowledge. (However, the IBM 1500 system, with its control of audio and slides, is the closest thing.)

22.6 Mechanical Amusements.

As the computer is the most general control box, so is the computer the most versatile control mechanism for pinball machines, model railroading, and other possible amusement-gallery pursuits.

There is no particular reason to suppose that this is of educational value, but neither is it clear that it isn't.

For instance, consider the game of "Space War," developed at MIT and the Air Force Cambridge Research Laboratories, which is played by two opponents, each with his own CRT and various controls. Each player controls the image of a rocket-ship on a common display, and can "shoot" at the other ship. The shots are visible, and a hit ends a round. Now, this game has many variations: the "gravitational field of the sun" may become an additional complication, and various constraint equations may be incorporated to constrain the movements of the ships, their fire power and so on.

I don't know what rationale existed for this programming effort, but I understand that the game is exciting and entirely worthwhile. Could not other games be designed which, while luring the young from their appointed pursuits, teach them something anyway? (That is, something more useful than, e.g the reflective ballistics of spheres, as taught in pool.)

I should also mention that a CRT-based amusement gallery-- or anyway, a "Space War" concession-- might well be able to pay for itself soon, if not now. (Such a setup can pull in a quarter every five minutes of operations.)

23.0 Computer Information Display

Information display, as the term is used in the Society for Information Display, means virtually any way of getting information out of a computer or other machine: whether through neon numberical tubes (Nixies), illuminated push buttons, printing machines or even cathode-ray tubes. However, cathode-ray tubes, in the general-purpose display system, are obviously far more powerful and versatile than any of these other devices; and while the cathode-ray tube may be supplanted in the future by such things as the electroluminescent panel or the volumetric display, the principles upon which these devices operate will not be grossly different from those we have already had to develop for the CRT.

Let us assume that the less general forms of information display are trivial, and concentrate on the big one, the CRT.

There are a number of different types of digital cathode-ray displays, and it must be kept in mind that they can all be made to do more or less the same things, but at different rates and with different amounts of versatility, speed, precision, attractiveness, and cost.

23.1 Computer Information Display Programs (as distinct from "programmed instruction").

The potentialities of computer display are remarkable.

Moving text is possible upon the CRT display screen: it may move as a scroll from bottom to top; it may move from side to side; or it may adjust itself to accommodate new insertions or deletions or rearrangements upon the screen.

Drawings may be made upon the screen. These may take the form of static line drawings, and such drawings may be crafted and rearranged upon the screen by the user.

Within Sutherland's fabulous SKETCHPAD system (which, it should be noted, has never been duplicated), line structures may be made linked and movable. But this involves deep complications that make it very expensive. A derivative of this with important educational implications: manipulable mathematical drawings have been created (at BBN) which allow the user to understand relationships by seizing a part of the drawing, moving it on the screen, and seeing what happens to the rest of the field.

Three-dimensional line drawings are also possible, though this involves far more computation. Such drawings are usually in the form of scaffolds or frameworks, since it is much easier to show each line complete than to calculate what parts of an object are behind what other parts. However, this "hidden line" drawing is possible too, thanks to the work of Roberts at Lincoln Labs.

Sketchpad has also been made three-dimensional, through the efforts of Timothy Johnson. However, this does not, to my knowledge, have "hidden line" capability. Under Sketchpad, manipulable diagrams are possible, where the user may seize a part with his light pen and drag it or shift it or rotate it upon the screen by moving the light pen.

One of the most extraordinary features of a working display system is the fact that its use can be taught very swiftly, sometimes immediately. One way to do this is to let the user choose from among the things he wants the system to do by reading out the possible alternatives onto the screen, so that he may then select the next thing he wants to happen with a light pen. This is called a "menu."

Tracer programs are possible which log the different actions of the user. But depending upon the complexity of the things to be remembered, this may or may not tie up a lot of time and space. (In teaching applications, what things to record is an important question.)

Halftones are possible, but expensive, and it is not clear that they are desirable, or what is to be gained from their use. There may be exceptions to that, but these do not necessarily have applicability to teaching.

The creation of salable materials to be viewed and handled by the user on the computer-display screen must be regarded as one of the most arresting possibilities that exists for publishing of the future. These that follow are only a few possibilities.

It should be noted also that materials for such systems can be more easily created and modified than any other kinds of pictures; and they are *intrinsically* better, since they can be magnified, transformed and subjected to presentational convolutions and variations far beyond anything visible on a conventional projector or blackboard.

23.1.1

Manipulable explanatory diagrams.

Computer display makes it possible to extend the illustration and diagram in every imaginable way. The applications I will mention below are only a small beginning.

23.1.2

Allegorical mnemonics. For example, "The House of Intellect"-- a picture of a house whose roof is astronomy and whose walls are physics, history, etc. It would be nice for the viewer at the screen to be able to "walk into" such a house and find a gallery of diagrams he could manipulate.

23.1.3

3-D Explorations and Dissections.

What we might call penetrable 3-D displays could be suited for anatomy, archaeology, architecture. In high school biology, for instance, it would be nice for the viewer at the screen to be able to "dissect" some creature upon the screen, using the light pen as a "scalpel," and seeing what the insides are like when he can ask for a label or explanation of each thing. It would be possible to present drawings of machinery in which the machinery actually moved, and could be "taken apart" as it was moving for the internal workings to be viewed.

23.1.4

Hyper-Comics.

For the undermotivated, we could have *hyper-comics*-- comic strip presentations, with talk balloons, which permitted the user to "converse" with different characters upon the screen, choosing the person he was going to "speak to" and the thing he was going to "say" from various alternatives before him. The visages could then reply in character.

While elaborate equipment is involved in all these things, the more elaborate aspect is in fact the design of the programs that make them run. It is a very easy thing to program to make say, a drawing appear on the screen and simply sit there. All you have to do is put in the coordinates of the parts of the drawing and arrange some way for that list of coordinates to be delivered to the display machine.

It is quite another thing when the position of one object must depend upon the position of another object, and the different members depend one upon the other. Programs for these purposes must be constructed with techniques called "recursive" procedures and/or "list processing,"~~-~~ which involve - or, ideally, *should* involve-- such unusual decoding hardware as built-in push-down stacks and associative memories. List processing usually means ways of handling changing strings and networks of interconnected information by computer programming instead of special hardware. In practice this generally means that the machine can keep track of very large structures of information whose pieces are scattered all about the computer memory, and while it is thinking about wheels within wheels within wheels can remember location and position of all the outer wheels as well. List processing effectively makes memory storage more flexible. Systems with certain hardware recursive features are considered more elegant-- that is, systems able to automatically consider wheels within wheels, "the object next to," etc.

From this extremely brief discussion of programming, let us turn to a discussion of the hardware; for it is today only the hardware that is available.

23.2 Dynamic CRT Displays.

The "dynamic" cathode-ray display is any device which responds at once to instruction from the computer, or to constantly re-examined instructions within its own core memory. This machine can (if hooked to a computer) respond with all the speed of that computer. The dynamic display must be repeatedly refreshed by the computer or a memory device, else it will fade at once. For this reason it is also called a volatile display. (By convention thirty frames per second is thought of as a suitable framing rate for flicker-free performances, but this will vary with programming and other circumstances.)

23.2.1 Direct control refreshment. (Explicit instruction to display). In this method, the computer explicitly sends a series of instructions to a display scope. These instructions are of a form like "illuminate the point at 400 vertical, 750 horizontal," or "draw a line from 400 vertical, 750 horizontal to 400 vertical, 800 horizonatal."

The computer program must, therefore, explicitly concern itself with sending out display instructions-- as often as the display can use them, as often as there's time for during the rest of the program, or as often as the eye will need. This method is very inefficient.

23.2.2. Display refreshment direct from computer memory by cycle-stealing.

This method requires a display that recognizes instructions (at least a "branch" instruction). Cycle-stealing is a procedure whereby an external device may sample something in a computer's memory without affecting the computer's activity, save by delaying it slightly. The external device rings a doorbell, tells the computer "give me the contents of location 349," and receives those contents in the next memory cycle. The computer merely holds its breath during this pickpocket operation, and none of its central activities are affected. This differs from the instruction-to-~~dence~~device method in that the display does not wait on the computer, nor must the computer explicitly furnish materials to the display as part of its program. Rather, the display may thread its way throough the computer's memory following the display program it finds there, and the computer charges the display between these requests by rearranging that display program. Since typically the computer has time for five or ten operations between thefts, the two may function together neatly.

The expensive displays are of this type. They are expensive because they have complex instruction decoders that can do a number of different things upon a single instruction: light a point, draw a line, paint a character.

Examples include the IBM 2250, the DEC DISPLAY-8 (338), and various machines made by IDI, Tasker, ~~Vard,~~ Bunker-Ramo, and Stromberg-Carlson.

23.2.3 Independent core memory for display refreshment. This machine can be like, or the same as, the cycle-stealing model: if it is given an independent core, the computer may be completely freed between calls from the user, while a picture (but only a still picture) stays on the screen.

23.~~2.6~~ 2.4 CRT Display with Circulating Memory.

Where relatively small amounts of information are to be displayed-- say, a thousand characters of text, or a selection among 50,000 possible points-- a circulating memory may be employed with a volatile display. A circulating memory is one which goes around and around ~~at~~ at a fixed speed; this includes delay lines, drum and disc. In effect this is like a storage scope, (though the computer may just be able to change parts of the display, which is not ordinarily practicable on a storage scope.) The refreshment memory is usually completely filled, with one space in memory for each space on the screen. (Hence it will not, like the core-refreshed display, have room for extra standby materials not currently on the screen.)

Raytheon DIDS-400, IBM 2260, Control Data DD-210, Buhker-Ramo Teleregister 210, G-E Datanet 70, Sanders 720 Communication and IBM 1510, are all machines of this type. All but the last use delay lines. The last three have peculiarities: the Datanet permits the storing of vertical and horizontal straight lines among the characters, which permits boxes and lines. The Sanders 720 stores groups of spaces as special characters, has certain editing functions built into the hardware, and can be used as an intercom without a computer. The IBM 1510 (part of the 1500) uses a desk memory, and stores its contents as a pattern of dots rather than particular characters, though the programmer treats it as divided into characters or special pictures (of a larger size).

23.~~3.7~~ 2.5 Video-refreshed digital displays. Analog television scan is clearly the most inexpensive method of putting a picture on a cathode ray screen, through an ordinary television monitor. This can be done in various ways, depending on the form of character generation employed. In the monoscope method, the characters are permanently marked in the television camera tube, and the camera beam is rushed around to cross appropriate characters in the appropriate way as needed. ~~A simpler way is to scan a storage tube with a TV display. (This is usually done in a single scan converter tube: see below.)~~ I believe the United Aircraft system actually gates the TV scan dark and bright according to the message. This is complicated.

23.3 The stored display, while it has nowhere near as much action, is nonetheless a powerful tool and far less expensive. It works simply: a picture is plotted on the screen in one of the modes described above, and it remains there. What is called a stored display usually employs a storage tube, one which holds the image electrically. (After a time-- five minutes or more-- the picture will have crept and bled, and must be replaced.) The additive property of the storage scope gives the user a sense of action, since lines, words and figures can keep being added to it, although you cannot remove them except by clearing the screen.

While such systems are not yet economically feasible, there is reason to suppose that a storage display on every pupil's desk will be the basic arrangement for teaching systems of the future. Feasibility and economics require that the following be settled:

Sufficient mass memory for large quantities of material.

Further memory, less accessible, for far-fetched materials.

Fast input-output rates from

mass memory and to screens.

Efficient complex storage of large bulks of interconnected materials.

Effective time-sharing monitors for handling large numbers of stations on small computers.

Effective handling of 'background' tasks, for efficient in-between use of computers

Why storage display? The storage display does not require constant transfer of information from the central computer in order to show its contents. Station cost today is about $5000, and, in the future, the floor's the limit. Systems for drawing mathematical curves, especially upon a storage scope, have shown themselves to be useful and even lively.

One system (Teleputer) is commercially available, another is *almost* commercially available (1500), another is *around the corner* (Tektronix). In addition, several considerable units exist in prototype.

23.3.1 TELEPUTER

Culler, at Santa Barbara, has written a number of programs for a storage CRT system called the Teleputer, which was developed for him by the firm of Bolt, Beranek and Newman. The Teleputer operates over phone lines. Using his programs, students of mathematics may sit at the scope and experiment with relationships, seeing visually what results from each transformation or formula they want to try.

The Culler setup at Santa Barbara has a classroom with a Teleputer for each student. This is being extended--though probably not on that scale-- to Harvard, Kansas and elsewhere. (See section on "On-Line Numerical Programs," 22.1.2)

23.3.2 IBM 1510

While the 1510 display terminal of IBM's 1500 system (q.v.) is technically a dynamic system, the details of the disk refreshment scheme permits it only to be replaced, not modified. This is not essential, just unfortunate.

Anyway, it amounts to a storage tube. It has a limited pictorial capacity. One complete 1500 classroom is already in the field, and many more are on order.

23.3.3 TEKTRONIX MESHLESS STORAGE SCOPE.

Old-fashioned storage tubes are cranky, having a fragile metal mesh which capacitively maintains the image on the screen. The Tektronix scope, already available in oscilloscopes, behaves at low cathode voltages like an ordinary CRT, but above a certain threshold voltage retains the image on the screen.

Tektronix is preparing to market a five-inch computer output terminal in a few months, and has also a ten-inch prototype. Project MAC intends to couple these scopes with newly designed circuit-array character generators, to produce complete terminals requiring low data transfer rates for only $5000. (It is alleged that 500 of these assemblies are now contemplated for M.I.T.) Others, such as Engelbart, intend to put these scopes into service sooner with shared character generators.

23.3.4 HUGHES COLOR STORAGE TUBE.

The Hughes Corporation has a high-resolution color storage tube. It has the disadvantage of really having only two colors: rust and chartreuse. The first writeover is brownish-red, and a spot gets greener as more and more electricity is read onto it.

Unfortunately, this narrow color range would presumably be of no use to the color-blind, to whom the distinction between red and green is unclear.

23.3.5 IBM XEROGRAPHIC TUBE.

This tube (called by them an 'electrostatic storage tube,' which confuses it with other types), is actually, for all practical purposes, a variant of the Xerox machine. A cathode ray deposits a static-electric image on an inner membrane; a toner-- presumably granules of carbon-- is dusted across the other side of the membrane, and sticks to the image part. The picture will stay for months. Apparently a high vacuum is not required, and eventual production costs will be low. There are some disadvantages: the system requires illumination from outside, and the tube (currently) needs to be tilted to make the image. But it can be erased quickly, has very high resolution, and requires no electricity at all when it is merely showing an image.

23.4 SCAN CONVERSION.

It is possible to place an image on a storage CRT and then re-scan it, using the beam to read its values out rather than put the picture in. This is called scan conversion, since often the process has as its purpose changing one sort of scan (e.g., radar spiral) to another (video raster).

There are two types of scan conversion tubes, which we may call one-bottle and two-bottle. The two-bottles scan conversion tube can read with the CRT at one end while it writes with the CRT at the other end.

The scan conversion tube may be used as a way to read from a digital storage CRT to an ordinary TV system, for inexpensive multiple monitors. However, training a camera on the storage tube is easier and may be less expensive.

This device may also be used to create a fixed display for various guns of a multi-gun tube (see below).

23.5 MULTI-GUN TUBES

A multi-gun CRT has more than one cathode, and each of these beams may be manipulated independently, given the circuitry. It can present a number of different picture traces at once. The number of guns in a cathode ray tube may be indefinitely large. In practice the most that are commercially available in a single tube are five or six. There are various applications in which at least one gun might reasonably be dedicated to the regeneration of images ("background" images) which are not going to be changing very much. This part could come from a scan conversion tube. (Note: NASA recently built this system.) In this way a single active computer display can be shared among more terminals if they all share part of a picture, since it will have less to do in each. Or different material can be presented on the same scope shot from different guns, to create a super-active computer display There is a problem of the

driven by several computers at once.

synchronization of guns-- how to make the different pictures overlap correctly-- but there are no deep problems.

23.6 WIRED-IN FEATURES: CHARACTER GENERATION, STROKES AND LINES, CONICS, COORDINATE TRANSFORMATION, and OTHER ANALOG FUNCTIONS. Also ACCESSORIES.

The direct-control and core-refresher volatile cathode ray displays, because they may have their own instruction decoders, may be wired to interpret the decoded instructions in a large number of different ways. That is, they may be trained to make any wired-in picture fragment on receipt of a given row of pulses. These may include point plotting, straight line drawing, and other analog functions. One capacity under development for machines of this type is so called "conic" generation, that is, the ability to draw the various conic sections-- chiefly lines, parabolas and ellipses—automatically under a simple programmed instruction. This would amount to a built-in French curve directly available for various plotting functions, and would greatly simplify the drawing of curves.

It is possible to build various functions of computation directly into the display device. This is expensive, but it may be valuable. For instance, the most elaborage piece of display equipment, the ESL Kludge, is capable of storing points as information regarding positions of a point on three coordinates. This information is put through an analog transformation on its way to the screen, with the result that an object so represented can be "rotated" on the screen without any effort by the computer: all the user needs to do is manipulate the three dimensional rotation control, and the display revolves accordingly.

Analog operations of almost any kind may be wired into the display device, waiting for the signal. This would include the capacity to compute smooth curves by algebraic formula--but besides coordinate rotation, above, which ones would be useful?

A few words on the ways that letters and numbers are made on the screen. Character generation in direct-control cathode-ray setups follows many different courses. The simplest to describe is character generation by points, in which the computer simply lights up sufficient specific points (usually within some fixed-size matrix) to make a character on a space on the screen. This method is used in the Digital Equipment Corporation character generators, the system in the IBM 1510, and others. Another way is by *lines*; short strokes are put upon the screen, connected in such a way as to make up jagged (but not unattractive) letters. These can be straight, as in the IBM 2250, or curved, as in the IDI and Tasker instruments. A very fast technique is the shadowmask tube: this employs a cutout mask interfering with a thick cathode-ray beam. The mask casts a shadow on the face of the tube in the shape of the letter through which the beam has passed. Obviously, this beam has to be aimed *twice*: once as it leaves the gun, when it must be pointed through the appropriate cutout in the shadowmask, and again when the resulting extrusion must be aimed at some specified place on the screen. This method is by far the fastest means of plotting text, since it takes not much longer than plotting a single point. However, the characters are somewhat ugly, as they must be mechanically suitable for suspension on a punched-out disc in the middle of a vacuum tube. However, it is not unthinkable that aesthetically acceptable shadowmask tubes could be created, possibly employing two "shots" through the mask to make a single character, rather than one.

23.6.9 ACCESSORIES

Around the basic cathode ray tube many accessories and refinements (often referred to by such technical titles as "bells and whistles" of "spinach") are possible. Pushbutton arrays are a common accessory; it is customary to arrange these for easy re-labelling (to suit a new program or section of a program) by an overlaid or underlaid sheet of paper. Outputs off the screen, visual or aural, are also commonly thought useful. Real-time musical performance is not yet feasible.

23.7 COLOR AND 3-D CRTS.

23.7.1 COLOR CRT.

Color CRT displays using the conventional RCA system shadowmask tube have been built experimentally be RCA and the Digital Equipment Corporation. ~~One is~~ Still another is actually available from ITT.

Information International is working on an additive projection color system.

23.7.2. THREE-DIMENSIONAL DISPLAYS

Several three-dimensional computer display systems exist on some level. None are practicable for anything yet. Researchers at Bell Labs have produced stereo pairs for perception experiments out of photographs ~~inside~~ make one at a time; ~~Van~~ van Dam at Brown intends to ~~rut~~ run a stereoptican on a 2250 screen.

23.7.2-1 3-D WITHOUT VIEWERS.

(Pulsating Mirror)

One researcher at Lincoln Labs has placed a mirror of silvered Mylar next to a display, and ~~inside~~ make the Mylar to pulsate in synchrony with alternate left-and-right presentations on the screen. The viewer looks in the Mylar and sees the display, as it were, in space. However, this technique is probably restricted to points, or perhaps lines. Calculating the angles to make this suitably stereoscopic is, of course, complex.

At least one display may be able to produce a true three-dimensional form in space. This is the so-called "volumetric", or turbine, display.

TURBINE DISPLAY

This consists of a sort of translucent propellor mounted under a clear dome. The propellor is so curved that during each revolution there once appears a piece of its surface at every point in the display's volume, and can be seen from above or the side.

To make any three-dimensional form appear, then, we must project rays of light straight up from below their intended points at each instant the propellor is at the right height. (Presumably a CRT would project upon it from below.)

The timing problem, therefore, introduces a catastrophic complication to the display. In most dynamic computer displays, only one point can be illuminated at a given moment. In the propellor display, it will be often the case that several points must be illuminated at the same instant. (The limiting case, of course, would be to show the propellor itself, in which case every point would have to be lit up simulaneously once per revolution.) Perhaps some method may be found of delivering simulaneous beams of light, but this may depend on fancy parallel processing and display output ~~dences.~~ devices.

23.8 NON-CRT COMPUTER DISPLAYS

Many different systems are under investigation for computer display without cathode-ray tubes. These tend to be panels divided into crosshatch arrays of cells that can be lit up or turned off. Some of these are individual storage units, where each cell can be held on or off by the equivalent of a transistor-pair, others not.

23.8.1 WITH STORAGE: BITZER PLASMA DISPLAY.

Bitzer, at the University of Illinois, has created a display that uses cells of plasma (more like the glow of neon lamps than the radioactive melt of stellar plasmas). This system may be susceptible to batch fabrication at low cost; it has storage capabilities; and pointing devices may be possible which send pulses back out of the cells, at a great saving in cost.

23.8.2 With storage or without: Luminous diode arrays.

One of the simpler possiblitlies for mass batch fabrication is the array of luminous diodes: that is, bits of semiconductor material that glow when electrically driven. These arrays may be designed for storage or non-storage, as needed.

23.8.3 With storage: Magnetic-domain panel.

Boards are under construction whose cells are tiny magnetized areas. The direction of the magnetic fields may be altered in millionths of a second. Fine powdered material clinging to the surface is affected by this, so that under one magnetic orientation it is visible and under another it is not.

This is also a storage device. It must have a light shined on it.

23.8.4 Without storage: Luminescent panels.

Electroluminescent panels are sandwiches of two conductor plates and a glowing spread in between. Capacitance between the two plates-- that is, pulsating voltage differences between the plates-- turn on the area between.

Electroluminescent panels can be made with divisions into many irregular shapes, for general-purpose computer display

23.9 Group classroom display.

It would be possible to have an explanatory computer display for whole-class viewing. This could be a roll-in computer display setup. That is, it would not be necessary to have the equipment all in one classroom, but rather a curriculum of display materials could be prepared, and the entire system--computer, display, and contained material--rolled into the classroom where it could be used by the teacher, who has presumably familiarized himself with the facilities beforehand. This could be rented from the publisher or a daily or a weekly basis.

This may be an important interim solution long before displays are to be found at every desk.

It might be ventured that this would not be much better than the overhead projector, save for the added movement. I am not sure. For one thing, the teacher could be given various instantaneous access features far beyond any now available in any sort of projection system. Indeed, the teacher could have two display devices to himself, one of them being dedicated simply to the fast manipulation of the indexes he needs, and the other showing what the students see. Such an approach ties the teacher in with the new materials, since the illustrations are under his control.

The discretionary access of the teacher could extend across vast reaches of material, a potentially vast library perhaps equivalent to that of seven well-drilled assistants operating slide projection equipment and immediately responding to instructions. One important requirement is that this be friendly and attractive to the teacher, and quickly and easily learnable. We are assured of neither of these, but I strongly suspect that both of these desiderata are attainable.

24.0 COMPUTER TEACHING SETUPS ("CAI")

A number of computer-based teaching systems have been attempted. What to call them, if indeed they all deserved a common title, is unclear. "CAI," for "Computer-Assisted Instruction," is a term that seems to have been proprietory with IBM; but it may be passing into the public domain.

I will mention first, the different levels of activity being generally undertaken in this area; and second, the only commercial machine on which they can be made to occur.

24.1 Skinnerian.

There is, of course, Skinnerian programmed instruction, of which the less said the better. Since it relies entirely on the timing of "reinforcements," there is no need for branching techniques. I do not know of anybody trying it on the computer.

24.2 Drill-and Practice Systems.

After Skinnerian comes something we might call "Drill and Practice," which would be any system used for presenting drills, verifying the correctness of the student's answer, thrusting him through some sort of compensatory scheme if he has done wrong, and putting him through the material swiftly if he does right.

"Drill-and-practice" was a name used by researchers at Stanford for a computer teaching setup they used for supplying drill material to individual students in real schools. It fed out through teletypes, and was used by only one student in a class at a time (each classroom had its teletype in a closet area at the side of the room). Individual students would be scheduled for seances, and answer drill questions, usually (I believe) in arithmetic.

24.3 Socratic Systems.

"Socratic system" has come to be the generic term for computer teaching setups in which the computer, taking the role of firm but genial tutor, asks, replies to, corrects and generally prods the student in English sentences. The most famous of these systems is called PLATO; it resides currently, I believe, at the University of Illinois.

The Socratic teaching system attempts to get away from the drill-

and-practice format by attempting to work on the student's insights. For instance, it will ask him a question and respond actively to the approach he demonstrated in answering the question. Thus it is more exciting to be with. However, all the possible byways of the student's thought must be either planned in advance or arranged so that they may be safely ignored.

The motto of these systems might be "tut, tut." Socratic systems in their current versions are very hoity-toity. They are usually carping, never satisfied, and pretend to know everything. The pressing character of dialogue with this system, while it probably keeps the student alert, might be a terrific strain.

A deeper criticism is that examples of this teaching method that I have seen appear dangerously smug about the knowledge they contain and the proper method of evaluating it. I strongly suspect these systems of bidding to produce smug, unthinking graduates who wait to be told the right answer, and won't believe that none is known.

24.4 Coursewriter.

IBM CAI, or Computer Assisted Instruction, has been heavily influenced by all the above systems, and is simply an eclectic mixture of them. Under Uttal and now Grubb, the IBM effort has concentrated upon mounting operational systems which permit the generalized input and handling of short branching text structures. However, the philosophy of these systems has always been such that they have not been called "branching text structures," but rather "correct answer paths" and "wrong answer paths."

The result is Grubb's Coursewriter language, which has recently been extended to Coursewriter II, the basic language of the IBM 1500 system. This is built around the author's labelling possible student reactions to his questions with such commands as "wa" (wrong answer) and "ra" (right answer). The thought that someone might like a system such as the 1500 for the arrangements of materials that were not divided into right and wrong seems not to have occurred to anyone. I believe that the man who writes teaching programs under Coursewriter must prepare several alternative answers for each question and call all but one of them wrong answers if they trigger separate chains of events. Actually, there are also provisions for alternate right and wrong answers as well as 'don't care' provisions (the author has the option of not caring about some parts of the student's reply, concentrating on others).

Essentially Coursewriter is a blank sheet of paper with certain characteristics. The best programs under this system may approach the Socratic approach; or they may be Skinnerian ~~on~~ or anywhere else on the drill-and-practice scale. The author preparing materials for Coursewriter needs in principle only to understand the Coursewriter language, and need know nothing about computers. In fact this is false. Coursewriter is an awkward, clumsy language, in spots just a mask over the more conventional machine operations (such as counting). Its details are much easier to understand if you understand what is actually occurring in the machine.

24.5 Monitoring and Reporting.

It should be mentioned that the CAI systems in use and under discussion all contain recording systems for monitoring the student's progress. Of course, whether the information being collected is too little or too much may not immediately become clear. One direction in which this may go is what may be called the Narrative report: that is, the teacher (and presumably the parent) will receive a printed notice something like: "This student is indicating great insight and a range of interests...."

24.6 IBM 1500 Instructional System.

The IBM 1500 system is the only system now commercially available-- or almost available-- for computer-assisted instruction. It consists of a small IBM computer-- either the 1130 or the larger 1800, as the customer prefers-- and a number of student terminals. The student terminals are of several kinds: the 1510 cathode ray display, which has been discussed above; the 1512 visual image display, which has been ~~discovered and~~ discussed elsewhere;

a typewriter keyboard, and a light pen for pointing. The only thing that ties all these materials together is the system program, called "Coursewriter II," and the IBM 1500 operating system, which remains in command of the computer at all times. The creator of teaching programs for the computer communicates with the system in the Coursewriter language; the student knows not of Coursewriter, but simply responds to questions presented by the machine.

This system can be used for anything from Skinnerian instruction to Socratic instruction; the system itself is indifferent to the kind and style of material or presentation, and the programs within it can be either linear or widely branching.

However, there are certain limitations built into the system as presently constituted. One is simply the input-output rate of the machine. There can be 32 fully-outfitted student terminals, and there is a great deal of material to be switched to and from core memory, disc, tape and terminals. The computer must follow pointers, the material of the teaching program. While this in itself does not take very much time, the computer must also effect all the input and output transfers called by within that teaching program. For each computer cycle that is occupied in input or output operations no computation can take place. IBM is hoping that despite all the work to be done for the different terminals, the accounting and list processing, the system, fully loaded, will still be able to respond to all student inquiries within three seconds. This remains to be seen. It is not unthinkable, but it is not assured.

It is not clear whether IBM's 1500 terminals can be turned to other uses. The possibility of putting hypertexts (q.v.) on a 1500 does not seem feasible. It might work for a few terminals, but considering the response times desirable and the amounts of data needed, it is hard to see that terminals like 1510's (with their current disk-refreshing arrangement) could support this kind of an effort.

The IBM 1510 display (the cathode ray display supplied with the IBM system) employs a circulating memory, in this case a disk. The different terminals (up to 32) are assigned different tracks on a disk; and the computer reads out information into these tracks, where they are then picked up by the read heads dedicated each to the service of its particular scope. (The 1510 scope is divided into little rectangles, each of which may or may not hold a character. There may be sixteen lines, and forty spaces in each line. Actually, it is a dot matrix of 240 by 96 dots, and each character is an 8 by 12 dot matrix. However, the programming system also allows a 16 x 36 "graphic image", which may be some sort of picture or fancy piece of lettering or anything. I do not know whether the programming system permits these images to be superimposed one on the other.

25.0 HYPERTEXTS

I have coined the term "hypertext" for what might also be called "free structured text" "non-linear text," "network text," "graph structured text" and other things besides.

I would like to emphasize my

distaste for extending the bothersome terminology of programmed education to hypertexts. Hypertexts are not, if you please, programmed, but rather written and edited. ~~It~~ They ~~is~~ are read by a reader or user. There is no reinforcement anyplace.

Programmed education in its present form stems from a misguided metaphorical application of the findings of pigeon learning experiments to the experiences of school. While many things in the experience of school probably follow learning curves, learning theory is as relevant to education as Newton's general theory of gravitation is relevant to riding a bicycle. While the general principles have an abstract bearing, the practical difficulties lie along far different lines.

Programmed learning in its present form extends the idea of learning from its pigeon cognates of, say, color-discrimination and pellet reinforcement. Kernels of truth are dropped to the student and reinforced with pellets of encouragement.

I have intimated in other writings that hypertexts, or various hypertext techniques and structures, are virtually universal in their possible uses. I stand by this assertion. However, for the different sorts of purposes in civilized society, different kinds of hypertexts are going to prove to be relevant. Here I want to discuss simply those that fall within the possible realm of secondary schooling.

1. Hypertexts for individual student use. There might be an actual course, with syllabus and learning goals, wholly prepared for individual learning within this system and without the help of a teacher.

2. There might be a system of course adjuncts for use either under the control of the teacher or (on an after-hours basis) under control by the student. (The after-hours arrangement would be like a language laboratory, except presumably much more interesting and therefore less susceptible to neglect.)

3. For the sorts of research papers that are prepared in some high schools, a fairly large system of source materials for research texts could be assembled. While they could be brought to hand immediately by the console user, preparing a research paper from them would

still require them to be read, assimilated, organized in the mind, and gradually hammered out into a final written piece. The very accessibility of the materials would exert pressure for their meaningful organization. The instructor would know that the student had seen the better materials, so that the use of inferior materials, or inferior use of good materials, would be a recognizable deficiency in the work.

4. For the motivation of the unmotivated, the titillation of the mediocre, and in general student interest, why not prepare a comic book system, employing what I have called "hyper-comic" techniques? This would have lots of zowie for revitalizing the sullen and the dreamers.

For experimentation with complete actual courses on the elementary or high school level, I would suggest the following three alternatives, pitching them roughly at the eighth grade but providing materials both above and below that level.

1. Geography, with map materials going down to a rather fine level of detail. The user would be able to get narrative materials on the places of the world; he

would be able to take "trips," following roads, rivers and air routes and reading material on the places he was "passing," and then review the places he had seen.

2. World History. The history of the world, at least as it is told to eighth-graders, could be put in the machine and organized into a number of separate narrative trails. It would be possible to ask the user his preference and the sorts of things he was interested in, and arrange (e.g.) a swash-buckling trail, a military trail, a diplomatic trail, a romantic trail, and others, each opening into common central materials for review and overview.

3. ~~Mathmetics.~~ Mathematics. This would have various trails, mainly in prose but with pictorial and demonstrative material too, explaining for the practical-minded and the abstract-minded the same general abstract principles, permitting excursions into the whys and hows that are usually omitted from the subject. There would be exercises, but not arranged in a fixed compulsory pattern.

It has been proposed that a multi-level encyclopedia on all subjects should be created. I consider it too early to begin thinking about this. I do not consider it too early, however, to begin thinking about the large complex text on a single subject which would be accessible by beginner and knowledgeable adult:

The grand history hypertext with maps, battles, economics, biographies

The great math hypertext, with exercises, tricks, diagrams, and surprises

The biology hypertext with enlargements, "dissections," animations.

Techniques are possible which simply can't be done any other way. For example, there is what I would like to call reverse testing, or constructive testing. Instead of the instructor's choosing a subject, and then asking a question about it, why not let the student demonstrate what he knows voluntarily, choosing the subject and the details in negotiation with the machine? (I should like to point out that this is what anybody does when he wants to make an impression and seem bright to someone else.) The system could enquire about details he is omitting, rather than perniciously trying to find him wrong, but checking on details as appropriate. Naturally, various logging techniques would be employed to enable continuing improvement of the materials in the system from the surveillance of what is being done with them. A principle feature in the use of such systems for teaching is their tie-in with already learned materials for insight. An explanatory sequence can be much more jointed and flexible, a much wider lattice, so that the different sequences in which the material is available could provide for a much wider range of possible personal styles and interests.

A note on selling hypertexts: the hypertext system could be put on a pupil-hour basis. It may well be possible to carry a remote terminal around for demonstrations, and set students or teachers down before it. The material can come from home offices via teleprocessing.

26.0 HOLOGRAPHICS.

Holography has been exploited in connection with lasers, for practical reasons rather than out of any intrinsic connection; but the connection will probably be permanent. Holography is the most startling and dramatic form of image storage and display to be discovered since the movie. It is virtually incomprehensible, both in theory and in the flesh. Its "negative", made without a camera, is a pattern of whorls and blobs meaningless to the naked eye: yet on command this "negative" becomes, before the naked eye, a three-dimensional image of the object that was holographed. ¶ The light of lasers is coherent, that is, it travels in synchronized wavefronts. The exact pattern of vibration of every quantum of energy is precisely in step with the others. This creates some remarkable properties. All the individual quanta in the bundle of light from a laser travel in phase in the same direction. Now, light quanta do not actually fly straight, but vibrate as they go, crosswise to their line of travel. If we looked closely at the path of one quantum, we would see not a straight line but a wiggly one. A laser beam, then, is a bundle of quanta vibrating in exact synchronization as they pass a given point. If you were to slant such a beam (first spread out through a reducing glass) onto a photographic plate, it would produce a ribbed pattern, since the arriving quanta, being at different portions of their wiggle, would be clustered in patterns of rows. As I understand it, holography is built out of this type of wavefront patterning. There is no lens. ~~The~~ A reference laser is shined on a photographic plate, and another laser is shined on the subject in the presence of the plate; the two showers of light meet irregularly, and at the place they meet there appears a peculiar interferographic pattern called the hologram.

This hologram has extraordinary properties. First, it is incomprehensible to the naked eye, and indeed to any viewing machine save one using the kind of light that made the picture. Second, when laser light of exactly the frequency of the original laser is shined upon the hologram, it appears again as an image-- but the viewer sees it in three dimensions! Indeed, he can move his head around and see part-way "behind" the object. (This process of turning a hologram back into an image is called wavefront reconstruction.) Three: What is even more confusing is that separate pieces of this overall picture each contain the whole picture, and can be used to view the whole scene. Four: Almost any number of pictures can be superimposed one on the other, but only one may be seen at a time, by shining slightly different laser beams on it; the other photographs will appear, as it were, called forth by the beams that made them. By varying the parameters of the laser, or the laser's position, different views may be seen or entirely different pictures shown. (There is some limit: there begins an image degradation when too many images are superimposed one on the other. That is, "static" makes the apparitions begin to look slightly fogged and greyish.)

Color holography and holographic movies are in the developmental stages, but have drawbacks. Color needs at least three lasers instead of one. Movies, at least if the no-glasses stereo is to be preserved, are restricted to one-person viewing, perhaps on the old Mutoscope principle. In general, however, the holographic image is produced by two different wavefronts hitting a photographic plate together, producing by their collision an overall patterning, much as two superimposed designs of parallel or concentric lines will ordinarily produce some other overall pattern (a moire pattern). The pattern produced by a laser and reflected laser meeting and interfering with one another on a surface is called interferographic.

The typical setup for laser photography, or holography, of a thing employs a laser whose beam is split in two; part of the beam goes to the film to set up the first interferable pattern, the other goes to the subject, and later bounces off.

Holograms may also be produced without lasers. Many different well-ordered showers of light can produce reconstructible interferometric patterns, or such is my vague understanding. However, the advantage of the laser is very special: the laser is controllable and repeatable in its behavior, and more than one different laser may theoretically have the same wavefront characteristics as another. This is not so, for example, when holograms are made using a piece of ground glass. The slightest rotation of the ground glass, the slightest motion of the ground glass, will turn the picture back into groups of meaningless splotches. Now: how could laser interferography be used in schools? I see several possible applications, but they boil down.

26.1 SPECIAL HOLOGRAPHIC EXHIBITS.

Cycloramas or "models" could be shown in three dimensions, showing battle scenes (made with models), relics of the past in three dimensions, and so on. These would be easily transportable, and need much less space than they appeared to occupy, but difficult to set up and lacking in point. Ordinary photographs are much easier, and the color pictures possible with conventional methods are much more realistic.

26.2 LASER BOOK.

The most promising in my view is the possibility of a "laser book," that is, a book whose rigid pages are made of holograms; the student studies with the book under a laser beam. Not only may the illustrations, and even the typography, be three-dimensional; the student may turn to a new presentation simply by *tilting the book appropriately*. This could be used for handling particular branches in a conventionally programmed text, presenting quick-look material, or even presenting hypertexts without a computer. (Possibly a special stand for the book, or an adjustable laser, would be necessary.)

This may not be as fantastic as it sounds. The first $750 laser came out just six months ago. The first $350 laser came out last month. I think we may expect one of those sensational electronics price drops with lasers, and see them get down to five or six dollars each.

There's also the matter of student safety. While I'm sure that this issue can be settled straightforwardly on a medical/technical basis, the people who object to fluoridation may also worry gravely about their children's eyesight even if all medical testimony is to the contrary. These feelings deserve some respect.

EXHIBIT

With this paper I include three books: *Paddle-to-the-Sea* by Holling; *LSD* by Alpert, Cohen and Schiller; and *Applications Manual for Computing Amplifiers*, by the Engineering Staff of Philbrick Researches.

These books deserve to be looked at. They illustrate traits that I have been hypostatizing, advocating and advertising for the hypertext. I think these traits come more naturally in the hypertext; but putting together this exhibit, [redacted] has lately persuaded me that many of those editorial traits I hope for in the electronic beyond are possible here on earth, in print. It's a matter of how you make the books.

Paddle-to-the-Sea, it may not be immediately realized, is a *very dull story*. (Imagine the text without illustrations.)

Yet in its mosaic pictorial setting-- where the black-and-white drawings and explanations may be studied or ignored, according to taste, or allowed to contribute nonspecific insights-- it becomes a vivid, [redacted], absorbing, informative [redacted] story.

LSD is a long argument: a book that does not take sides, but sustains an [redacted] interesting pair of viewpoints on a controversial topic. This is the first "equal time" book I believe I have seen, although another book interestingly full of arguments is Hospers, *Introduction to Philosophical Analysis*.

Applications Manual for Computing Amplifiers is a beautiful book. It contains many of the virtues I have been talking about: it is appealing as an object; its structure is immediately made clear and kept clear-- there is no getting lost; it is friendly and welcoming, even boisterous; it is playful while being as respectful of the reader as a top-level briefing. It makes each lesson separately approachable; it contains fast-answer charts; and the parts are easy to find. The front and back should be looked at carefully.

I rather think this Philbrick book is what textbooks ought to be like. If they aren't something is wrong somewhere. Why can't there be a high school history or chemistry text that looks like this?

Before the Web, before the Internet, before personal computing, there was Ted Nelson, who believed in a wonderful new world and wanted to build it his way.

With his fun words--
pedagnology
teachotechnics
edujection
thingamatronics
and proposed devices--
Fliptych (p.44)
Projectern (p. 88)
Nelson tells us what the future may be like five years from now-- in 1972!

Wild and determined, he takes us through quaint devices and possibilities of the 1960s, and flings them forward in time-- including such curiosities as Kodak's Miracode, IBM's WALNUT system, and a computer called the Fabri-Tek Bi-Tran Six.

Of course he discusses diabolical possibilities of print media--
wall charts
printed kits and dossiers
split pages
double spines

But then on to the hot stuff-- hypertext, and even hypertext by hologram!

QUOTES FROM THE BOOK

Why is it that the student fails, not the teacher?

For the motivation of the unmotivated, the titilation of the mediocre, and in general student interest, why not prepare a comic book system, employing what I have called "hyper-comic" techniques? This would have lots of zowie for revitalizing the sullen and the dreamers.

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...

The grand history hypertext with maps, battles, economics, biographies
The great math hypertext, with exercises, tricks, diagrams, and surprises
The biology hypertext with enlargements, "dissections", animations

PREDICTION, P. 178--

A CRT-based amusement gallery-- or anyway, a "Space War" concession-- might well be able to pay for itself soon, if not now. (Such a setup can pull in a quarter every five minutes of operations.)

Got THAT one right!
(Pong came six years later--
note that Bushnell, the creator of Pong,
still credits Spacewar with being the first computer game.)

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